DPEARTMENT OF THE INTERIOR

FINAL

ENVIRONMENT STATEMENT

PROPOSED

DEVELOPMENT OF COAL RESOURCES

IN

EASTERN POWDER RIVER WYOMING

Prepared by the

DEPARTMENT OF THE INTERIOR

Frank Gregg

Director, Bureau of Land Management
Washington, D. C.

SUMMARY

Draft ( )   Final (X)   Environmental Statement

Department of the Interior, Bureau of Land Management

1. Type of action: Administrative (x)   Legislative ( )

2. Brief description of action: This environmental statement is developed in two parts: an updated regional analysis of the cumulative impacts of existing and anticipated coal development activities through 1990 and a site-specific mining and reclamation plan analysis. The site-specific analysis is based on one formal proposal (Buckskin Mine) for mining federal coal by 1980, 1985, 1990, and end of mine life.
Involved are:

A. Approval of one mining and reclamation plan on an existing lease.

B. An updated analysis of 9 mines operating on federal leases and 5 mines with environment statements in progress.

C. Assessment of additional activities which contribute to the cumulative impact of coal development in the region.

Annual production estimates for the Buckskin Mine are 2 million tons in 1980, 4 million tons in 1985, 4 million tons in 1990, and 4 million tons annually till the end of mine life. Combined with existing mining expected to continue through 1990, a total of 173 million tons would be produced annually by that date.

3. Summary of cumulative environmental impacts by 1990:

A. Population of the region would increase by 22,000 over 1978 base.

B. Employment in the region would increase by 3,900 jobs.

C. Disruption of social order due to rapid growth and subsequent changes in community structure.

D. Conflict between "new" and "old" life-styles. Small town atmosphere would be lost.

E. Transportation arteries, including rail lines, would experience heavier average daily traffic leading to significant increased accident potential.

F. Industrial and municipal use of water would increase by 34,035 acre-feet per year, possibly reducing amounts available for other uses.

G. Water quality would be lowered; total dissolved solid levels would increase.

H. Air quality would be lowered in terms of all presently regulated pollutants.

I. Vegetation would be disturbed and destruction of soil horizons would occur on 59,403 acres.

J. Possible overall reduction of soil and vegetative productivity of mined areas even after reclamation.

K. Livestock and wildlife forage would be reduced by about 130,000 animal unit months (AUMs) during mining.

L. Soil and vegetative (9,726 AUMs) productivity and wildlife habitat would be permanently lost on 3,242 acres converted to urban areas.

M. Recreation use would be intensified, urban recreation facilities would not meet increased population needs, and the quality of outdoor recreation experiences would decline.

N. Wildlife habitat, carrying capacity, and populations would be adversely affected on 59,403 acres.

O. Present visual quality of the landscape would be changed as a result of mining, mine facilities, new roads, railroads, transmission lines, and urban expansion.

P. Approximately 2 billion tons of coal would be extracted.

Q. Cultural resources in areas of surface disturbance would be committed to either destruction or salvage and increased amateur collecting would occur.

R. Topography of mined areas, presently consisting of cliffs, abrupt breaks, and rolling hills, would be changed to smoother contours.

S. Some geologic contacts, strata, and fossil occurrences would be revealed during the mining process and others would be destroyed.

4. Alternatives considered: Two alternatives are presented in Chapter 8: The No-Action Alternative (Low-Level Scenario) and High-Level Scenario. The low-level scenario is based on existing coal mines with a coal production of over 1,853 million tons by 1990. The high-level scenario is based on proposed, existing, and potential coal mining with a coal production of 2,378 million tons by 1990.

5. Comments on the draft environmental statement were requested from various agencies, the state clearing house, and interest groups. See Attachment A.

6. Date draft was made available to EPA and the public: October 15, 1978
Date final was made available to EPA and the public: March 28, 1979

Attachment A. Comments on the draft ES were requested from the following agencies and interested groups. Those marked with asterisks provided oral or written comments.

Federal

Advisory Council on Historic Preservation*
Department of Agriculture
    Soil Conservation Service*
    Forest Service*
Department of Commerce*
Department of Energy
Department of Health, Eduction, and Welfare*
Department of Housing and Urban Development
Department of the Interior
    Bureau of Mines*
    Bureau of Reclamation*
    U.S. Fish and Wildlife Service*
    Heritage Conservation and Recreation Service*
    National Park Service*
    Office of Surface Mining
Department of Labor
    Mining Safety and Health Administration*
    Occupational Safety and Health Administration
Department of Transportation*
Environmental Protection Agency*
Federal Power Commission
Interstate Commerce Commission
Mountain Plains Federal Regional Council
National Historic Preservation Council
Office of Economic Opportunity
Office of Management and Budget
Water Resource Council

State

State of Wyoming Clearing House coordinated comments from all interested state agencies.*

Local

Campbell County Commissioners
City of Gillette-Campbell County Department of Planning and Development*
Converse Area Planning Office*
Converse County Commissioners
Mayor, City of Douglas
Mayor, City of Gillette*
Mayor, City of Glenrock

Nongovernment Organizations

American Institute of Mining and Metallurgical Engineers
American Mining Congress
American Sportsmen's Club
Campbell County Gem and Mineral Society
Campbell County Historical Society
Campbell County Rod and Gun Club
Citizens for Orderly Energy Development
Defenders of Wildlife
Fort Fetterman Sportsmen's Association
Friends of the Earth*
Izaak Walton League
League of Women Voters
Members of the Casper District BLM Advisory Board
Murie Audubon Society
National Audubon Society
National Council of Public Land Users
National Energy Law and Policy Institute
National Environmental Health Assocation
National Resources and Environmental Council
National Wildlife Federation
Natural Resources Defense Council
Outdoors Unlimited
Powder River Basin Resources Council*
Powder River Wildlife Club
Rocky Mountain Center of the Environment
Shell Oil Company*
Sierra Club*
Society for Range Management
The Wilderness Society
Thunder Basin Grazing Association*
Wyoming Archeological Association
Wyoming Association of Conservation Districts
Wyoming Environmental Council
Wyoming Outdoor Coordinating Council
Wyoming Petroleum Association
Wyoming Stock Growers Association
Wyoming Wildlife Federation
Wyoming Wool Growers Association

TABLE OF CONTENTS

FOR

EASTERN POWDER RIVER COAL ENVIRONMENTAL

STATEMENT

REGIONAL ANALYSIS

TABLE OF CONTENTS (CON'T)

REGIONAL ANALYSIS

PROPOSED BUCKSKIN MINE

TABLE OF CONTENTS (CON'T)

PROPOSED BUCKSKIN MINE

CHAPTER 1

DESCRIPTION OF REGIONAL DEVELOPMENT ACTIVITY

BACKGROUND

Introduction

This environmental statement (ES) is in two parts. The first part is an updated regional analysis of the cumulative impacts of existing and anticipated coal development activity through 1990 in the region known as the Eastern Powder River Basin of Wyoming. Additional development activity in the region includes coal conversion, extraction and processing of other energy minerals (uranium, oil, and gas), development of utility and transportation systems, and activity related to population growth. This additional activity would contribute to the cumulative impact of coal development in the region.

The second part of this environmental statement analyzes impacts of the site-specific action, which is approval of the Buckskin mining and reclamation plan submitted by Shell Oil Company. Development of the Buckskin Mine is included in the cumulative development activity assessed in the regional analysis.

This document has been prepared by the Bureau of Land Management (BLM) and the Geological Survey (GS) in cooperation with the Forest Service (FS), the U.S. Fish and Wildlife Service (USFWS), and the Bureau of Mines.

Purpose of the Regional Update

This regional analysis has been prepared to update the regional analysis contained in the Final Environmental Impact Statement, Eastern Powder River Coal Basin of Wyoming (FES 74-55) filed on October 18, 1974. The update provides an assessment and analysis of cumulative regional impacts based on current coal production outlook and presently anticipated levels of regional development activity. This update also incorporates recent data, research, and impact analyses in subjects as air quality, water resources, soils and vegetation, cultural resources, transportation, and socioeconomic conditions.

The environmental statement prepared in 1974 covered the probable regional impact of the development and operation of fourteen coal strip mines, four mine-mouth, coal-fired generating plants, two gasification plants, and a 113-mile main line railroad connecting Gillette and Douglas. The statement also analyzed, on a site-specific basis, development or expansion of four mines (Wyodak, Rawhide, Black Thunder, and Jacobs Ranch) and the 113-mile railroad.

Since FES 74-55 was issued in 1974, the development or expansion of the four mines analyzed site specifically has been approved by the GS. Three mines (Belle Ayr, Cordero, and Eagle Butte) included in the earlier regional analysis and analyzed in separate site-specific environmental statements have also been approved by GS. Five additional mines (Caballo, Coal Creek, East Gillette, Pronghorn, and Rochelle) included in the earlier regional analysis are presently being analyzed in separate site-specific environmental statements. The status of coal mining approvals is summarized in Table R1-1. The right-of-way for the 113-mile railroad has recently been issued. The four new mine-mouth, coal-fired generating plants and two coal gasification plants have not been developed at this time. Completion of the Wyodak Plant discussed in FES 74-55 occurred in 1978, and no additional new power plants are currently projected within the region through 1990. The Panhandle Eastern Gasification Plant on a site near Douglas is still in the proposal stage, pending funding for construction and operation.

Scope of Regional Analysis

The scope of this updated regional analysis includes the cumulative impacts of existing and anticipated coal development together with impacts resulting from other developments occurring or expected to occur within the Eastern Powder River Basin Environmental Statement region by 1990. The ES region is the same as that analyzed in FES 74-55 (see Figure R1-1). The geographic area of consideration is that part of the Powder River Basin in Wyoming bounded by the Powder River on the west, the coal outcrop on the east, the Wyoming state line on the north, and the North Platte River on the south. The ES region, consisting of approximately 5 million acres (4,978,560 acres), includes all of Campbell County and a portion of Converse County. The principal communities are Gillette, Douglas, Glenrock, and Wright, Wyoming. The boundary of the region coincides exactly with the Eastern Powder River Basin Planning Unit within the Casper District of the Bureau of Land Management.

Those impacts which extend beyond the ES region are analyzed to the extent that they are more associated with regional development than with other actions outside the region. Elements which will be impacted on a broader

TABLE R1-1

STATUS OF COAL MINING OPERATIONS

Mine Name	Approved	FES* issued	DES** issued
Wyodak	X	10/74	
Dave Johnston	X	--***	
Belle Ayr	X	10/75	
Cordero	X	4/76	
Rawhide	X	10/74	
Black Thunder	X	10/74	
Jacobs Ranch	X	10/74	
Kerr McGee #16	X	--****	
Eagle Butte	X	9/76	
Caballo		3/79	
Coal Creek		1/79	
East Gillette			4/77
Rochelle		preparation of DES discontinued	
Pronghorn		2/79	

* Final Environmental Statement
** Draft Environmental Statement
*** Approval prior to enactment of National Environmental Policy Act.
**** No federal approval required.

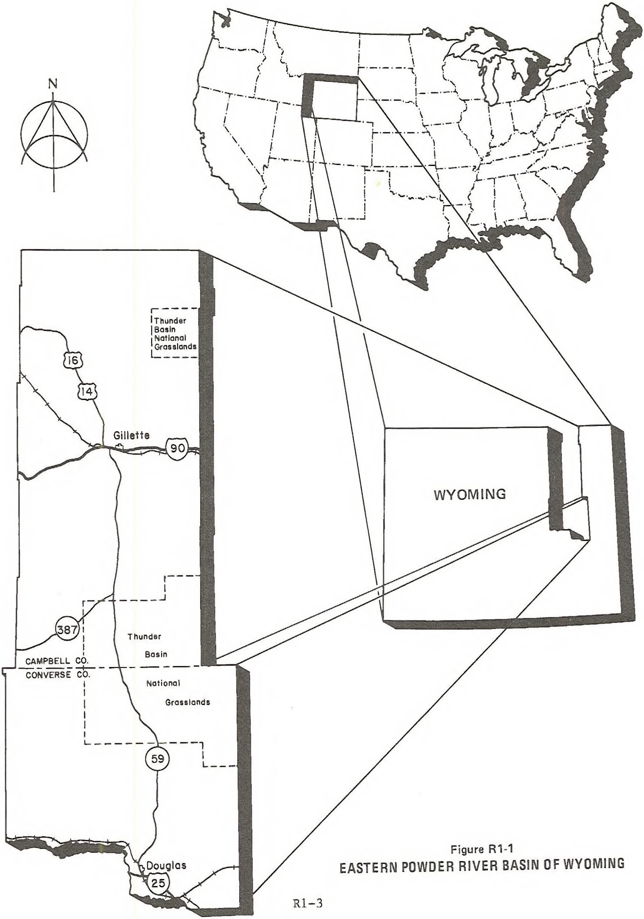


Figure R1-1
EASTERN POWDER RIVER BASIN OF WYOMING

geographic scope include social and economic factors, recreation, air quality, and transportation systems.

This ES does not propose new coal leasing nor does it commit the Secretary of Interior to a new coal-leasing program or the issuance of new coal leases.

The mining and reclamation plan (Buckskin Mine) analyzed in the site-specific part of this statement was submitted for review prior to the promulgation of initial regulations (30 CFR 700) required under Section 502 of the Surface Mining Control and Reclamation Act of 1977 (PL 95-87), and has not yet been reviewed for compliance therewith. Therefore, the mining and reclamation plan may not reflect the appropriate requirements of the regulations. However, to the extent possible, the applicable regulations have been considered in this analysis as federal requirements.

The mining and reclamation plan must be revised in accordance with the applicable regulations. As soon as the mining and reclamation plan is revised it will be evaluated by the Office of Surface Mining to determine compliance with the requirements of federal regulations 30 CFR 211 and 30 CFR 700. A discussion of the Surface Mining Control and Reclamation Act, and the regulations which implement it, is included in Chapter 3.

REGIONAL DEVELOPMENT SUMMARY

Three levels of coal development are assessed in the regional analysis: a probable level based on mining and reclamation plans presently filed with GS (including the site-specific action, Buckskin); a low level based on operating mines and those mines pending approval which have been or are being analyzed in site-specific ESs and were included in the earlier regional statement (FES 74-55) (see Table R1-1); and a high level based on proposed and potential mining in the region. Other major development in the region, both coal-related and noncoal-related, is added to each of the three levels of coal development in order to define three levels of regional development.

In 1974, the original regional analysis (FES 74-55) projected a probable level of development from fourteen mines resulting in an annual coal production of 150 million tons by 1990. There are now fourteen mines in the region, already approved or pending approval, which represent the low level of coal production (170 million tons annually by 1990) for the current analysis (see Chapter 8). Thus the probable level in the original analysis parallels the low level of the current analysis, except where production outlooks have been modified since 1974 (see Figure R1-2). The site-specific action under consideration (Buckskin Mine) is added to the low level to form a probable level of coal development (174 million tons annually by 1990) (see Table R1-2). The high level of coal development (330 million tons annually by 1990) represents the addition of potential new coal development to the probable level (see Chapter 8).

The various levels of coal development may be influenced by factors such as availability and economic recovery of coal, market demand and economic conditions, requirements for diligent development of federal coal leases, and decisions, regulations, or policies developed in the private, local, state, and federal sectors.

The probable level of development is described in detail below, and is analyzed in the impact assessment chapters (Chapters 4, 5, 6, and 7). The low and high levels of development are described and analyzed in the low- and high-level scenarios of the alternatives chapter (Chapter 8). A comparison of the impacts of the probable, low, and high levels of development is presented in tabular form in Chapter 8.

Probable Level of Development

Coal Development

The probable level of coal development consists of production from one proposed mine, whose approval constitutes the site-specific action, and associated production from the fourteen previously or separately analyzed mines through the year 1990. The mines pending approval are assessed individually in site-specific environmental statements completed or under preparation by GS. The cumulative regional impacts of these fourteen mines were also included in the regional analysis in the final environmental statement on the Eastern Powder River Coal Basin of Wyoming (FES 74-55) issued October 18, 1974. Mine data is shown on Table R1-2.

Coal-Related Development

The impacts of coal-related development are analyzed as components contributing to cumulative regional impacts of the probable level of development.

Wyodak Power Plant. In the summer of 1978, Black Hills Power and Light and Pacific Power and Light companies opened the 330-Mw capacity Wyodak Power Plant near Gillette. The plant requires about 2 million tons of coal annually, supplied from the adjacent Wyodak Mine which must increase production from the present 900,000 tons per year to meet this need. Since the plant is air cooled, water requirements are only about 130 acre-feet per year, supplied by the city of Gillette's effluent treatment system. About 75 people are employed at the plant. After construction is complete, no changes in plant facilities and capacity are anticipated prior to 1990 (personal communication, Morgan 1977).

Coal Gasification Plant. Plans for one coal gasification plant have been announced. This project is a joint venture of Panhandle Eastern Pipe Line Company and Peabody Coal Company. Coal to supply the plant would come from the Rochelle Mine, to be operated by a subsidiary known as Rochelle Coal Company, and located about 48 miles north of Douglas. The plant site would be about 15 miles north of Douglas. The gasification plant would be operated by another subsidiary known as Wyoming Coal Gas Company (SERNCO 1974). This plant was included in the cumulative regional analysis present-

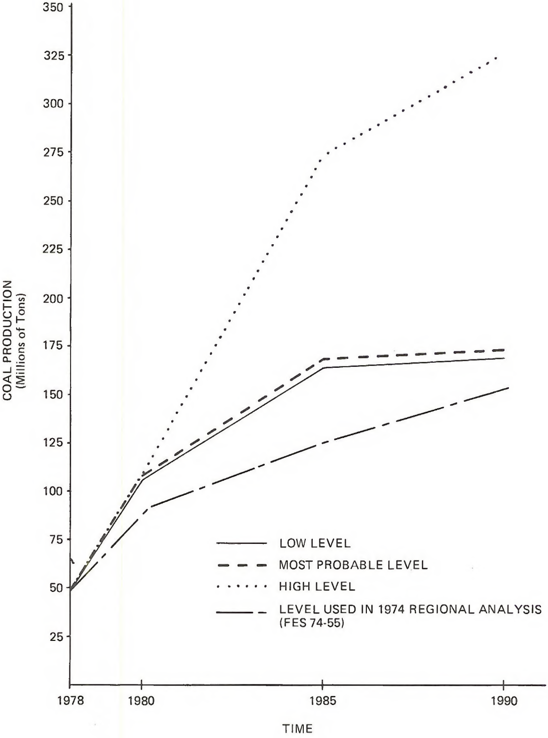


Figure R1-2
LEVELS OF COAL PRODUCTION

TABLE R1-2

PROBABLE LEVEL OF COAL DEVELOPMENT (EXISTING AND PROPOSED COAL MINING) BY 1990 IN THE EASTERN POWDER RIVER BASIN

Projects (All Surface Mines)	Annual Coal Production (MM Tons/Year) 1978	1980	1985	1990	Time Frame: Construction Start Up	Full Mine Operation	Mine Life (Years)
Site Specific Action							
Buckskin	0	2.0	4.0	4.0	1979	1985	20
Operating Mines							
Wyodak	0.9	2.5	2.5	2.5	1922	1979	98
Dave Johnston	3.2	3.2	3.2	3.2	1958	1970	43
Belle Ayr	18.5	20.0	20.0	20.0	1973	1985	23
Cordero	9.2	20.0	24.0	24.0	1976	1981	25
Rawhide	3.0	9.0	12.0	12.0	1977	1982	40
Black Thunder	5.8	13.7	20.0	20.0	1978	1983	40
Jacobs Ranch	2.6	10.7	15.7	15.4	1975	1984	23
Kerr-McGee #16	1.0	4.2	4.2	4.2	1978	1979	14
Eagle Butte	0.3	13.2	20.0	20.0	1976	1984	39
Environmental Statement In Progress							
Caballo	0.1	3.0	7.0	12.0	1977	1987	39
Coal Creek	0	4.0	10.0	10.0	1979	1983	36
East Gillette	0	4.0	11.0	11.0	1979	1982	35
Rochelle	0	0	11.0	11.0	1980	1984	29
Pronghorn	0	3.5	5.0	5.0	1979	1981	22
TOTAL	44.6	113.0	169.6	174.3			

TABLE R1-2
(cont'd)
PROBABLE LEVEL OF COAL DEVELOPMENT (EXISTING AND PROPOSED COAL MINING) BY 1990 IN THE EASTERN POWDER RIVER BASIN

Projects (All Surface Mines)	Total Permit Acres[2]	Federal Coal Acres	Cumulative Acres Disturbed by 1990[3]	Average Acres Disturbed Per Year[4]	Cumulative Acres Reclaimed by 1990
Site Specific Action					
Buckskin	1,760	600	377	50	14
Operating Mines					
Wyodak	3,240	1,880	363	50	243
Dave Johnston	13,990	9,660	2,760	80	1,565
Belle Ayr	5,960	2,440	1,947	165	1,643
Cordero	8,390	6,560	3,174	285	1,820
Rawhide	5,720	5,457	755	80	410
Black Thunder	8,280	5,884	1,285	175	975
Jacobs Ranch	4,960	4,352	1,760	170	1,345
Kerr McGee #16	960	0	559	57	572
Eagle Butte	4,470	3,520	1,208	85	611
Environmental Statement In Progress					
Caballo	7,850	5,330	1,220	195	805
Coal Creek	9,605	5,800	1,270	185	808
East Gillette	3,440	3,440	1,100	77	990
Rochelle	5,000	10,820	873	160	555
Pronghorn	2,640	4,000	455	45	310
TOTAL	86,265	69,743	19,106	1,859	12,666

TABLE R1-2
(cont'd)
PROBABLE LEVEL OF COAL DEVELOPMENT (EXISTING AND PROPOSED COAL MINING) BY 1990 IN THE EASTERN POWDER RIVER BASIN

Projects (All Surface Mines)	EMPLOYMENT[5]					
	1980		1985		1990	
	Construction	Permanent	Construction	Permanent	Construction	Permanent
Site Specific Action						
Buckskin	197	52	0	125	0	133
Operating Mines						
Wyodak	0	48	0	55	0	55
Dave Johnston	0	135	0	135	0	135
Belle Ayr	0	255	0	334	0	334
Cordero	0	166	0	277	0	277
Rawhide	0	327	0	430	0	430
Black Thunder	0	350	0	500	0	500
Jacobs Ranch	0	212	0	250	0	250
Kerr McGee #16	0	123	0	123	0	125
Eagle Butte	0	200	0	350	0	350
Environmental Statement In Progress						
Caballo	121	200	0	430	0	430
Coal Creek	194	55	0	250	0	250
East Gillette	5	110	5	161	0	161
Rochelle	200	190	0	190	0	190
Pronghorn	0	226	0	279	0	279
TOTAL	717	2,649	5	3,889	0	3,899

TABLE R1-2
(cont'd)
PROBABLE LEVEL OF COAL DEVELOPMENT (EXISTING AND PROPOSED COAL MINING) BY 1990 IN THE EASTERN POWDER RIVER BASIN

Projects (All Surface Mines)	Estimated Number of Unit Trains[6] for the Years 1980	1985	1990	Market Area
Site Specific Action				
Buckskin	200	400	400	Oklahoma
Operating Mines				
Wyodak	45[7]	45[7]	45[7]	Mine Mouth (Wyodak), South Dakota
Dave Johnston	0[7]	0[7]	0[7]	Mine Mouth (Dave Johnston Power Plant)
Belle Ayr	2,000	2,000	2,000	Colorado, Texas, Arkansas, Kansas, Ohio, Iowa
Cordero	2,000	2,400	2,400	Wyoming, Texas
Rawhide	900	1,200	1,200	Iowa, Indiana
Black Thunder	1,370	2,000	2,000	Texas
Jacobs Ranch	1,070	1,570	1,540	Arkansas, Louisiana
Kerr McGee #16	420	420	420	Unknown
Eagle Butte	1,320	2,000	2,000	Southern, Midwestern, and Ohio Valley States
Environmental Statement in Progress				
Caballo	300	700	1,200	Nebraska, Michigan, Indiana
Coal Creek	400	1,000	1,000	Texas
East Gillette	400	1,100	1,100	Unknown
Rochelle	0[7]	0[7]	0[7]	Mine Mouth (Wyoming Coal Gasification)
Pronghorn	350	500	500	Minnesota, Iowa, Wisconsin, Illinois, Gulf Coast States
TOTAL	10,775	15,335	15,805	

Note: Mine information was developed from mining and reclamation plans currently on file with the Area Mining Supervisor, GS.

1 Additional federal coal reserves under lease are anticipated to be mined as a part of this operation in the future, which may extend indicated mine life.
2 All acreage within the area of operations for the mine.
3 Only acreage disturbed by mining operations. By 1990, 3,717 additional acres will be disturbed by mine facilities.
4 Average annual rate per new surface disturbance by mining activities.
5 Employment data in the mining and reclamation plans were updated where possible by personal communications with the mining companies.
6 One unit train equals 100 cars, each car having a capacity of 100 tons of coal. Does not include return traffic. Coal exported from the region is shipped south, east, or southeast.
7 This number does not represent full transport of the mine production by unit train. Coal consumed at mine mouth is generally transported short distances by truck or private rail.

ed in FES 74-55. Information concerning this proposal has been updated for this ES.

The gasification plant would require 1,000 acres for facilities, plus additional acreage for access roads, rail line, and pipelines. It would process 11 million tons of coal annually and require 5,000 to 8,000 acre-feet of water annually. From this, 270 million cubic feet per day of 960 to 970 BTU per cubic foot of gas would be produced. By-products would be 8,000 barrels of liquid petroleum products and about 100 tons of sulfur per day. The company has proposed constructing a power plant of 60-Mw capacity to supply electrical needs of the plant.

The proposed gasification plant would require a 24-inch, 475-mile gas line. About 20 miles of this line would be in the region of analysis and would require 200 acres of land. Water would be supplied from a diversion on the North Platte River and from a well field adjacent to the plant site. The water system would require about 10 miles of water pipeline. A private railroad would be established between the Rochelle Mine and the plant site. This line would be single track with sidings and electric powered. The line would be about 40 miles long and basically parallel State Highway 59 (personal communication, Leon Fergus 1977).

Presently, the gasification project plans are not proceeding, pending financial arrangements. For purposes of analysis, financing is assumed to be available by 1980. When financing becomes available, at least 2 years (1982) would elapse before construction begins. Construction would require about 4 years and employ an average of 2,000 workers. Permanent employment at the plant would be about 800 individuals.

This proposal is included in the cumulative regional analysis. However, a site-specific environmental analysis will be prepared at the time a specific gasification project is proposed.

Railroad. Most coal produced in the region will be exported to other parts of the United States to be converted or utilized.

Rail service is provided via two main lines of Burlington Northern (BN) (principal rail service) and one main line of Chicago and North Western (C&NW). Upgrading of existing tracks is presently in progress. BN and C&NW are jointly constructing a major new rail line between Gillette and Douglas, portions of which are in operation (personal communication, Interstate Commerce Commission 1977). Construction and operation of this rail line was analyzed both regionally and site specifically in FES 74-55, and federal rights-of-way were issued March 20, 1978. (See also Chapter 2, Transportation.) It is expected that about 173 miles of rail line and anticipated spur lines and sidings will be constructed by 1990 as mines begin production (from mining and reclamation plans on file with the Area Mining Supervisor, GS). In addition, a 40-mile private rail line for transporting coal for gasification (see discussion of coal gasification) would be built by 1990 (personal communication, Leon Fergus 1977). The main line between Gillette and Douglas, about 113 miles, will probably be completed between 1980 and 1985. Spur line development would be timed to coincide with industry start-up periods. Projections in this ES indicate that coal production could increase from a present 45 million tons per year to 174 millions tons per year in 1990. Rail transport requirements would be affected similarly. The quantity of coal to be shipped would increase at a fairly constant rate to 1990 (personal communication, Interstate Commerce Commission 1977), based on coal production projections.

On February 21, 1978, the U.S. Court of Appeals for the District of Columbia Circuit in the *Sierra Club* v. *Interstate Commerce Commission* found that the discussion of offsite impacts (those occurring outside the region) resulting from increased rail use contained in FES 74-55 was inadequate. The Interstate Commerce Commission was directed to assess and consider these impacts in connection with further proceedings directed by the court concerning the railroad construction application for the Gillette to Douglas rail line. Impacts occurring outside the region from increased rail traffic are discussed in the regional analysis, Chapters 2 and 4.

Union Pacific (UP) and C&NW recently announced plans to increase rail carrying capacity for shipments of coal. C&NW has sought a federal loan guarantee to finance the rehabilitation of its route from Shawnee, Wyoming to Fremont, Nebraska. C&NW and UP have agreed to collaborate in the development of a new rail line connecting a point east of Shawnee with the existing UP line at a point east of Torrington, Wyoming. Because these plans are tentative, they are not included in the impact analysis of this ES.

Other Major Regional Development

The impacts of major noncoal developments are included in the regional analysis as part of the cumulative regional impacts.

Oil and Gas. Oil and gas production was recorded from 166 active fields in the Powder River Basin during 1975. There are an additional 44 fields which are considered temporarily nonproductive. A great majority of the wells classed as nonproductive are shut in, awaiting secondary or tertiary recovery procedures to be implemented. These shut-in wells are considered to be in the process of reactivation.

The region produced approximately 12.3 million barrels of federal oil, or approximately 9% of the total federal oil produced in the state of Wyoming in 1975.

Oil and gas reserves will become increasingly depleted by present extraction methods, and total production figures have shown a decline since 1973. However, a highly active oil and gas exploration program in the region is expected to continue to add new fields to the discovery list. Also, new recovery methods, such as the secondary and tertiary programs, will tend to improve recovery by extending oil and gas operations in the region for at least 50 years.

Employment in the oil and gas industry in the region was approximately 5,000 people in 1974, and by 1990 is expected to increase to only 3% above the present figure. Total acreage presently used for oil and gas activity is about 4,800 acres. Acreage affected by oil and gas

exploration and development will increase about 10% by 1990 (personal communication, GS, Conservation Division, Casper 1977).

Uranium. Uranium exploration and mining is confined chiefly to the districts of Pumpkin Buttes in southwest Campbell County and Southern Powder River Basin in northwest Converse County (see Map 10, Appendix A). It is assumed that uranium activity will continue to increase through 1990.

There are presently three producing uranium mining operations (a mining project may involve several open pit, solution, or underground mines, owing to the frequent occurrence of uranium in small diffuse ore bodies) and two mills in the region. It is anticipated that there will be six mining operations by 1980, producing a total of 2,561,000 tons per year (TPY) of uranium ore. In 1985, twelve mining operations will be producing 4,445,000 TPY, while in 1990, the twelve operations will be producing 4,745,000 TPY. Three uranium mills will be operational in 1980 processing 6,200 tons per day (TPD), while in 1985 and 1990, seven mills will be operating, processing 13,200 TPD in 1985 and 16,200 TPD in 1990.

Developments proposed to be operational by 1980 would result in employment of approximately 1,800 workers for uranium mining and milling activities. Uranium employment is projected to reach 2,850 by 1985 and then 3,015 by 1990. It is anticipated that 6,200 total acres will be disturbed by uranium activity by 1980, 15,300 by 1985, and 21,800 by 1990. By 1985, 6,000 acres will be reclaimed, and by 1990, 12,500 acres will be reclaimed. It is anticipated that the majority of development activity will occur in the Southern Powder River Basin (Tennessee Valley Authority 1976; Kerr-McGee, July 1977; United Nuclear 1977; Nuclear Regulatory Commission 1977; Bickert et al. 1976; *Engineering and Mining Journal*, December 1975; Wyoming Department of Economic Planning and Development 1978).

Other Construction Activities. Tri-County Electric Association, Inc. plans to construct a 59-mile, 230-kv transmission line from the Wyodak Power Plant east of Gillette to a site on the Campbell-Converse county line. Then, approximately 15 miles of existing transmission line originating from the Dave Johnston Power Plant near Glenrock will be extended north by Pacific Power and Light Company, requiring about 28 miles of new construction to connect with the Tri-County Electric portion. The purpose of the combined 87 miles of new transmission line and associated facilities is to improve the delivery of power for present and anticipated demands of the coal, uranium, and oil and gas industries. Construction may be under way by 1980 (personal communication, Royce Harbicht 1977).

Municipal development in the region is under way, some of which will extend beyond 1980. The community of Wright is expected to increase by an average of 200 housing units per year for 10 years (personal communication, Bob Huff 1977).

Coal Slurry Pipeline

There is a proposal by Energy Transportation Systems, Inc. (ETSI) to construct a 1,667-mile, 38-inch pipeline capable of exporting 25 million tons of coal annually from the region to Arkansas, Louisiana, Mississippi, and Oklahoma in the form of a coal-water slurry (ETSI 1978). Some of the coal would come from existing mines in the region. ETSI filed an initial application for right-of-way for the slurry pipeline with the Bureau of Land Management and the Forest Service in 1974. A new application was filed in May 1978 with the Bureau of Land Management (BLM) and is in the process of being perfected.

Since detailed information about the slurry pipeline is not yet definite, analysis of the cumulative impacts of the proposed pipeline are not included in this ES. After final applications and detailed project data have been filed, the ETSI coal slurry project will be analyzed in a separate environmental analysis. Wyoming BLM has been assigned lead responsibility for preparation of this ES.

THE SITE-SPECIFIC ACTION

The site-specific portion of this ES analyzes the impacts of the specific authorization under consideration by the Department of the Interior. That authorization is approval of the mining and reclamation plan for the Buckskin Mine, after the plan has been modified to meet all applicable federal regulations. No federal rightsof-way are required as part of this action. The site-specific action is also included as a part of the probable level of development.

In May 1977, Shell Oil Company submitted the Buckskin mining and reclamation plan, in conformance with federal regulations 30 CFR 211 (May 1976) to the Area Mining Supervisor, GS. The plan outlines a surface coal mining operation on federal lease W-0325878, involving 600 acres (all private surface). The mine would be located approximately 10 miles north of Gillette, Wyoming, and would produce 4 million tons per year by 1990 to supply steam-powered generating facilities in Oklahoma. The mining area of operations or permit area is 1,760 acres, which includes the federal coal lease, a 1,000-foot operational perimeter around the lease, and the access and rail corridors.

Additional information from the Buckskin Mine plan is summarized by the first line entry of Table R1-2.

Required Authorizations for the Site-Specific Action

Assistant Secretary of Energy and Minerals

The Assistant Secretary shall approve the mining permit application (including the mining and reclamation plan) and significant modifications or amendments thereto prior to commencement of mining operations by the company.

Office of Surface Mining (OSM)

OSM, with the concurrence of the leasing agency (Bureau of Land Management) and GS, recommends approval or disapproval of the mining and reclamation plan to the Assistant Secretary of Energy and Minerals. Whenever a state has entered into a state-federal cooperative agreement with the Secretary of the Interior, pursuant to Section 523(c) of the Surface Mining Control and Reclamation Act (SMCRA), the state regulatory authority and OSM will jointly review mining and permit applications. Such an agreement with the State of Wyoming was signed in October 1978. Both agencies will recommend approval or disapproval to the officials of the state and Department of the Interior authorized to take final actions on the permit.

Bureau of Land Management (BLM)

BLM develops special requirements to be included in the reclamation plan concerning management and protection of all resources other than coal and the postmining land use of the affected lands.

Geological Survey (GS)

GS is responsible for development, production, and coal resource recovery requirements included in the mining permit.

State of Wyoming, Department of Environmental Quality (DEQ)

Since Wyoming entered into a cooperative agreement with the Secretary of the Interior, pursuant to Section 523(c) of SMCRA, DEQ and OSM will jointly review and act on the mining and reclamation plan and permits to mine authorized under a federal coal lease.

The Land Quality Division of DEQ issues permits and licenses to mine according to the approved mining and reclamation plan. The Air Quality Division issues permits for construction and operation after review of applications with regard to air contaminants and plans for control and monitoring. The Water Quality Division issues permits to construct water systems. The Solid Waste Division issues construction fill permits and industrial waste facility permits for solid waste disposal during construction and operation.

Wyoming State Engineer

Water rights for the mining and coal-processing operations are required from the State Engineer. The State Engineer also must authorize proposed water diversions and impoundments.

FUTURE REVIEWS

Future National Environmental Policy Act Review Points

Future coal-related actions beyond those proposed and analyzed in this ES will require additional assessment of environmental impacts. Such future actions may include:

1. Mine and reclamation plan approval for development of existing federal coal leases.
2. Major mine and reclamation plan modifications for existing operations. Specifically, existing mines must modify their mining and reclamation plans to come into compliance with the Surface Mining Control and Reclamation Act.
3. Issuance of coal exploration licenses.
4. Future proposals for development of unleased federal coal.
5. Replacement (exchange) of coal in areas of high environmental cost, such as alluvial valley floors, with other federal coal.
6. Permit and/or lease readjustments. Terms and conditions of federal coal leases are readjusted every 20 years, while mining permits are issued not to exceed 5 years, under conditions of the Surface Mining Control and Reclamation Act.
7. Federal authorizations for transportation and communication rights-of-way or other mine-related facilities.
8. Federal authorizations for plant facilities and transport systems for any major new industrial project.

Related Reviews

Preference Right Lease Application Status Review

Recent interpretation of the Mineral Leasing Act of 1920 by the Office of the Solicitor, Department of the Interior, has determined that areas of federal coal under preference right lease application (PRLA) cannot be leased if, prior to issuance of the prospecting permits, there had existed, on those areas, existing mining claims under the Mining Act of 1872. This interpretation would affect only the portions of the PRLAs under mining claims. Preference right lease applicants were required to submit abstracts of any mining claims on their applications to BLM by March 1978.

Preference right lease applicants were required by 43 CFR 3520 to prepare and submit initial showings indicating evidence of commercial quantities of coal to BLM by July 1977. As the PRLAs are processed, initial showings will be evaluated in technical reports and environmental assessments to be prepared jointly by BLM, OSM, and GS.

On September 27, 1977, under order of the District Court for the District of Columbia in *Natural Resources Defense Council* v. *Hughes*, the Department of Interior was enjoined from issuing any new coal leases until a supplemental coal programmatic environmental statement correcting the deficiencies of the original statement has been issued in final form and a new coal management program has been developed.

Department of Energy (DOE)

Under the Department of Energy Organization Act of 1977 (PL 95-91), DOE was authorized to set coal production rates on federal coal leases, review and concur on stipulations included in federal coal leases, and establish diligence requirements for development of each lease. Guidelines and procedures are being developed for coordination of DOE's responsibilities with those of the Department of Interior.

ANALYSIS GUIDELINES FOR THE PROBABLE LEVEL OF PRODUCTION

An analysis of impacts requires establishing guidelines for coal-related development. The following narrative and tables were developed to establish such guidelines for coal development and other concurrent regional development activities. Probable cumulative regional development activity for the Eastern Powder River Basin is shown in Table R1-3. As new development information becomes available these guidelines can be utilized to reflect the changes.

Guidelines

The following information was used for analysis of impacts:

1. Cumulative impacts are analyzed for three time points (1980, 1985, 1990).
2. Reclamation schedules vary for each mine. Normally reclamation is conducted as an ongoing program. After a surface mining operation has been in progress for 2 to 3 years, the reclamation of the mined land is accomplished at approximately the same annual rate as acreage disturbance.
3. Reclamation on an area is considered complete when disturbed lands have been backfilled, graded, contoured, and revegetated in accordance with an approved reclamation plan, and bond has been released (Wyoming Land Quality Rules and Regulations 1975, Surface Mining Control and Reclamation Act of 1977).
4. Since telephone lines are usually built within access road or railroad rights-of-way, no additional acreage of disturbance has been attributed to these installations.
5. Any impacts lasting after closure of mine and release of bond will be considered long term.
6. Acreage and water requirements used to analyze cumulative impacts are derived in Tables R1-3, R1-4, R1-5, and R1-7. Tables R1-6 and R1-8 summarize acreage and water requirements.

TABLE R1-3

CUMULATIVE DEVELOPMENT DATA FOR THE REGION
PROBABLE LEVEL OF DEVELOPMENT

	1978	1980	1985	1990
Coal Mining				
Number of Coal Mines*	10	15	15	15
Coal Mine Support Facilities:				
Miles of Rail Spurs	39	60	60	60
Miles of Telephone Lines	30	50	50	50
Miles of Access Roads	7	22	22	22
Miles of Conveyor System	0	7	7	7
Miles of Power Lines	76	93	93	93
Coal Related Development				
Number of Power Plants**	2	2	2	2
Number of Gasification Plants	0	0	1***	1
Miles of Railroad Line				
Main Line (Common-carrier)	26	113	113	113
Private	0	0	40	40
Uranium				
Cumulative Number of Mining Projects	3	6	12	12
Cumulative Number of Uranium Mills	2	3	7	7
Cumulative Number of In Situ Uranium Leaching Projects	0	0	1	1
Oil and Gas				
Area of Activity (Acres)	4,800	4,880	5,110	5,250
Other				
Miles of New 230-kv Transmission Lines	0	0	87	87
Population Increase (1,000's)****	0	4	18	22

Note: 1978 base, and based on mining and reclamation plans and indicated trends.
* Counts East Gillette and Kerr McGee #16 individually.
** Wyodak and Dave Johnston. Neil Simpson dismantled and incorporated into Wyodak.
*** Under Construction.
**** Centaur Management Consultants, Inc. 1978. Based on State of Wyoming projection model for Campbell and Converse counties: population increases represent increase over 1978 base population (37,780).

TABLE R1-4

ACREAGE REQUIREMENTS FOR DEVELOPMENT

Facility	Average Acres Required
Mine Surface Structures (coal and uranium)	100 per mine
In Situ Uranium Leaching Project	100 per project
Uranium Mill	500 per mill
Transmission Line (230-kv)	18 per mile
Power Line	6 per mile
Telephone Line*	0 per mile
Railroad Line (157-foot right-of-way)	21 per mile
Gasification Plant (includes pipelines, power, and access)	1,500 per plant
Power Plant	2 per megawatt
Population Increase	145 per 1,000 people
Conveyor System	10 per mile
Road (100-foot right-of-way)	12 per mile
Road (2 lane, 175-foot right-of-way)	21 per mile

* Assumed either within road, rail, or power right-of-way corridor.

TABLE R1-5

SUMMARY OF CUMULATIVE ACREAGES DISTURBED AND RECLAIMED BY COAL MINING ACTIVITY
PROBABLE LEVEL OF DEVELOPMENT

		Cumulative Acreage			
		1978	1980	1985	1990
Surface Mines Operations		2,515	4,733	12,934	19,106
Power Lines		451	558	558	558
Rail Spurs		859	1,260	1,260	1,260
Access Roads		128	264	264	264
Conveyor Systems		0	70	70	70
Mine Structures		1,039	1,500	1,500	1,500
Relocations		36	36	36	36
Totals:	Acres Disturbed	5,028	8,421	16,622	22,794
	Acres Reclaimed	1,234	3,495	9,887	12,666
	Difference	3,794	4,926	6,735	10,128

TABLE R1-6

CUMULATIVE ACREAGE DISTURBED AND RECLAIMED BY REGIONAL DEVELOPMENT ACTIVITIES
PROBABLE LEVEL OF DEVELOPMENT

	1978	1980	1985	1990
Acreage Disturbed				
Coal Mining Activity*	5,028	8,421	16,622	22,794
Power Plants	2,000	2,000	2,000	2,000
Coal Gasification	0	0	1,500	1,500
Railroad Line				
Main Line	546	2,373	2,373	2,373
Private	0	0	840	840
Uranium	5,000	6,200	15,300	21,800
Oil and Gas	4,800	4,880	5,110	5,250
Sand, Gravel, Scoria	200	200	620	1,280
230-kv Transmission Line	0	0	1,566	1,566
Population**	0	519	2,640	3,242
TOTAL	17,574	24,593	48,571	62,645
Acreage Reclaimed				
Coal Mining Activity*	1,234	3,495	9,887	12,666
Other Activities	900	2,400	6,550	13,300
TOTAL	2,134	5,895	16,437	25,966
Difference	15,440	18,698	32,134	36,679

* From Table R1-5.
** Acreage required for population increase over 1978 base municipal acreage.

TABLE R1-7

WATER REQUIREMENTS FOR DEVELOPMENT

Facility	
Per 1,000 Population Increase (urban)	190 A-F per year*
Mine Operation	20 A-F per million tons coal
Gasification Plant (270 Million cubic feet per day)	7,000 A-F
Power Plant (water-cooled)	10 A-F per megawatt
Power Plant (air-cooled)	0.4 A-F per megawatt
Uranium Operation	25 A-F per 1,000 tons of ore per day production
In Situ Uranium Leaching	225 A-F per year
Uranium Mill	1,000 A-F per 1,000 tons of ore per day capacity

* Based on present water use in Gillette. A-F = acre-feet.

TABLE R1-8

INCREASED WATER USAGE FOR THE REGION
PROBABLE LEVEL OF DEVELOPMENT

Annual Water Requirements (acre-feet)

Type of Use	1975	1978	Inc.*	1980	Inc.*	1985	Inc.*	1990	Inc.*
Coal Mines	170	980	810	2,200	2,030	3,400	3,230	3,500	3,330
Irrigation	10,000	10,000	0	10,000	0	10,000	0	10,000	0
Municipal**	3,990	7,220	3,230	7,830	3,840	10,550	6,560	11,290	7,300
Oil Field (water-flood)	12,000	12,000	0	12,000	0	12,000	0	12,000	0
Uranium Mines	80	140	60	230	150	400	320	430	350
Uranium Mill	500	4,200	3,700	6,200	5,700	13,200	12,700	16,200	15,700
In Situ Leaching Project	0	0	0	0	0	225	225	225	225
Power Plants***	7,500	7,630	130	7,630	130	7,630	130	7,630	130
Gasification Plant	---	---	---	---	---	7,000	7,000	7,000	7,000
Stock Water and Domestic	10,000	10,000	0	10,000	0	10,000	0	10,000	0
Totals	44,240	52,170	7,930	56,090	11,850	74,405	30,165	78,275	34,035
Sewage**** (Estimate of Water Used)	2,800	5,060	2,260	5,480	2,680	7,380	4,580	7,900	5,100

* Increase over base year (1975).
** Includes need for projected population increase in region.
*** Includes Wyodak air-cooled and Dave Johnston water-cooled plants.
**** Not a part of cumulative total.

CHAPTER 2

DESCRIPTION OF THE ENVIRONMENT

INTRODUCTION

This chapter consists of two parts: existing environment and future environment. It describes the physical, biological, and cultural factors which constitute the environment within the Eastern Powder River Basin of Wyoming, the region of analysis for this coal environmental statement (ES). The description of the existing environment updates information in the 1974 Regional ES (FES 74-55); it emphasizes those environmental factors most likely to be affected by the site-specific action and other possible future federal coal development. The description of the future environment discusses changes in the existing environment projected to occur by 1980, 1985, and 1990, without approval of the Buckskin Mine, which is the proposed action in the site-specific portion of the ES. Taken together, these descriptions provide the background for the analysis in Chapter 4, "Environmental Impacts of Regional Development,"since some alteration of these environmental elements would result if the site-specific action is approved, along with the continuation of development already under way or pending approval.

CLIMATE

Introduction

The climate of the region is typical of mid-latitude semiarid areas, with cold winters and warm summers (Trewartha 1961). The terrain is rolling and hilly. The mountain ranges that most affect the atmospheric flow over the Eastern Powder River Basin are the Big Horn Mountains to the west and the Black Hills to the east. Because the region is east of the Rockies and at a high elevation, little precipitation falls (normally about 14 inches per year). Most of the region's precipitation falls from air masses that originate over the Pacific Ocean, but some precipitation results from incursions of moist air from the Gulf of Mexico.

Variations in weather are generally related to extratropical low pressure systems that travel from west to east through the region. These large-scale meteorological systems can cause considerable snowfall during the winter and can generate strong surface winds.

Specific Climatic Factors

Temperature

Average temperatures do not vary greatly over the region since elevation differences are relatively small. In general, the temperature is lower at the higher elevations. However, lower elevations such as valleys can become cooler than nearby higher elevations because of cold air drainage, which results from strong radiational cooling. The most pronounced radiational cooling occurs on clear, calm nights.

The region is sometimes affected by chinook winds, which are warm winds that sweep down the eastern slopes of the mountain ranges to the west of the region. These winds usually blow from the direction of the Big Horn Mountains and sometimes blow from the other mountain ranges that lie farther to the west and southwest.

The warmest month of the year is July with daily maximum temperatures often 90°F or above, although maximum temperatures average in the upper 80s. January is the coldest month of the year with frequent daily minimum temperatures of 0°F or below (National Oceanic and Atmospheric Administration 1974). The monthly and annual average temperatures in or near the region are presented in Table R2-1.

Growing Season

The growing season is the number of consecutive days with temperatures higher than a specified value. Areas of high elevation and areas where cold air drainage occurs experience the shortest growing seasons. Locations at intermediate levels tend to experience the longest growing seasons. Drainage basins experience a higher frequency of frost than areas immediately outside the basins since cold air drains into the basins during the night and early morning hours. The length of the growing season at a particular locality is variable from year to year, depending on large-scale meteorological conditions. Some species of plants are vulnerable to light freezes while others are affected only by hard freezes. The average growing seasons for various stations in eastern Wyoming for temperatures of 32°F, 28°F, 24°F, 20°F, and 16°F are shown in Table R2-2.

The date of the first fall freeze is of particular importance in attempting to revegetate disturbed areas. The objective of revegetation is to establish a self-sustaining

TABLE R2-1

AVERAGE TEMPERATURE DATA (^{o}F) FOR SELECTING LOCATIONS IN OR NEAR THE EASTERN POWDER RIVER BASIN

Month	Gillette 2E*	Dull Center 1SE*	Casper	Midwest	Rockypoint 2NE*
January	21.9	23.6	22.3	24.0	19.2
February	25.0	26.5	25.9	27.3	22.1
March	30.9	32.8	32.4	33.9	28.7
April	43.3	44.7	43.0	45.2	42.5
May	52.9	54.3	53.1	54.6	52.7
June	61.3	63.7	62.0	64.0	61.4
July	72.2	73.4	71.1	73.3	71.4
August	70.2	70.7	68.9	71.2	69.7
September	59.9	60.4	58.1	61.1	58.9
October	48.7	48.6	46.4	49.9	47.3
November	33.8	34.5	33.3	35.3	31.7
December	26.1	26.3	25.5	27.8	23.3
Annual	45.5	46.6	45.1	47.3	44.1

Source: National Oceanic and Atmospheric Administration 1974.
Note: Averages are based on data for the period 1931-1955.
* Number of miles and direction that the station is located away from the main post office.

TABLE R2-2

GROWING SEASON DATA FOR THE EASTERN HALF OF WYOMING INCLUDING THE EASTERN POWDER RIVER BASIN
(BASED ON PERIOD FROM 1921-1950)

STATION	ELEVA-TION	Average Number of Days Between the Last Spring Occurrence and the First Fall Occurrence of Indicated Temperature (°F)					Average Dates of First Occurrence in the Fall of the Indicated Temperatures (°F)					Average Dates of Last Occurrence in the Spring of the Indicated Temperatures (°F)				
		32°	28°	24°	20°	16°	32°	28°	24°	20°	16°	32°	28°	24°	20°	16°
Casper*	5,322	130	150	174	192	209	9/25	10/2	10/15	10/22	10/28	5/18	5/5	4/24	4/13	4/2
Cheyenne*	6,139	130	149	169	189	213	9/27	10/4	10/15	10/25	11/5	5/20	5/9	4/30	4/19	4/6
Chugwater	5,282	102	127	150	172	187	9/13	9/22	10/3	10/12	10/19	6/3	5/17	5/6	4/24	4/15
Dull Center**	4,354	125	147	167	192	209	9/20	9/30	10/10	10/22	10/30	5/19	5/6	4/27	4/13	4/4
Gillette**	4,602	129	150	174	193	207	9/27	10/4	10/15	10/23	11/1	5/21	5/7	4/24	4/13	4/8
Kaycee	4,660	110	134	158	175	198	9/17	9/26	10/5	10/10	10/20	5/30	5/15	4/30	4/18	4/5
Kirtley	5,200	115	140	161	178	195	9/21	9/28	10/10	10/19	10/27	5/29	5/11	5/2	4/24	4/15
La Grange	4,720	120	142	167	185	201	9/21	10/1	10/11	10/20	10/28	5/24	5/12	4/27	4/17	4/10
Leo***	6,000	84	129	153	172	195	8/30	9/26	10/3	10/14	10/24	6/7	5/20	5/3	4/25	4/13
Laramie	7,211	113	135	159	176	193	9/19	9/28	10/10	10/20	10/26	5/29	5/16	5/4	4/27	4/16
Lookout***	6,969	96	125	150	163	181	9/7	9/23	10/2	10/10	10/20	6/3	5/21	5/5	4/30	4/22
Marshall***	7,010	60	83	122	144	166	8/18	9/1	9/22	10/1	10/10	6/20	6/10	5/22	5/11	4/27

TABLE R2-2
(cont'd)

GROWING SEASON DATA FOR THE EASTERN HALF OF WYOMING INCLUDING THE EASTERN POWDER RIVER BASIN
(BASED ON PERIOD FROM 1921-1950)

STATION	ELEVATION	Average Number of Days Between the Last Spring Occurrence and the First Fall Occurrence of Indicated Temperature (°F)					Average Dates of First Occurrence in the Fall of the Indicated Temperatures (°F)					Average Dates of Last Occurrence in the Spring of the Indicated Temperatures (°F)				
		32°	28°	24°	20°	16°	32°	28°	24°	20°	16°	32°	28°	24°	20°	16°
Metz Ranch	5,280	121	143	169	187	208	9/19	9/30	10/8	10/21	10/30	5/20	5/11	4/22	4/17	4/5
Newcastle	4,480	137	156	183	198	214	9/29	10/8	10/20	10/27	11/3	5/15	5/5	4/20	4/11	4/3
Pine Bluffs	5,044	124	146	171	191	204	9/21	9/29	10/14	10/23	10/29	5/20	5/7	4/27	4/15	4/7
Rockypoint***	4,100	123	141	165	186	204	9/22	9/30	10/11	10/21	10/29	5/22	5/13	4/29	4/18	4/8
Ross**	5,250	110	146	164	180	196	9/15	9/30	10/7	10/15	10/22	5/27	5/7	4/26	4/18	4/9
Saratoga	6,786	80	112	137	162	183	8/29	9/16	9/27	10/9	10/21	6/10	5/26	5/14	4/29	4/21
Sheridan Field Station	3,800	123	150	181	198	211	9/21	10/1	10/18	10/26	11/1	5/21	5/4	4/20	4/11	4/4

Source: National Oceanic and Atmospheric Adminiatration 1974, U.S. Department of Commerce (October 1989-1975).
* Station located at airport.
** Denotes atation within atudy area.
*** Number of milea and direction that the station is located away from the main post office.

vegetative cover (Atlantic Richfield Company 1977). To ensure survival during the winter, seedlings of grass, shrubs, or trees that are used for revegetation may need to be mature before the first day with a freezing or subfreezing temperature. The end of the growing season for 32°F typically occurs during the second half of September. For a 24°F criterion, the growing season ends during the first half of October, while for 16°F the growing season ends during the second half of October.

Precipitation

Total Precipitation. The precipitation totals (rainfall plus the water equivalent of snowfall) in the Eastern Powder River Basin are relatively low compared to the totals in other areas of the United States. The monthly precipitation is highest in May and June, and lowest in December, January, and February. The Eastern Powder River Basin averages 12 days of measurable precipitation during May, and only 5 days during October (National Oceanic and Atmospheric Administration 1974). The total monthly and annual precipitations for Gillette and Dull Center are listed in Table R2-3. The precipitation pattern for the region shown in Figure R2-1 is based on data from numerous cooperative stations.

Snowfall. Snowfall within the Eastern Powder River Basin varies with elevation. The highest annual average snowfalls of over 70 inches are experienced in the areas west of Gillette and south of Douglas. The lowest annual snowfalls measure less than 30 inches and occur in the extreme northwestern and northeastern corners of the region and near Highland Flats in the southern portion (U.S. Department of Commerce 1954-1975). The snowfall season over northeastern Wyoming lasts nearly 10 months, from September to June. The maximum monthly snowfall normally occurs in March.

Areas of high annual snowfall shown in Figure R2-2 are not necessarily areas having the heaviest annual precipitation. In some cases snow falls over higher elevations, while rain falls over the lower elevations as a result of higher temperatures at the lower elevations.

Snowfall intensities are generally not excessive throughout Wyoming. Usually about five times a year, stations at lower elevations record single-storm snowfalls in excess of 5 inches. Occasionally, 10 to 15 inches of snow may fall from one storm, but such amounts of snow are unusual outside the mountainous regions (National Oceanic and Atmospheric Administration 1974).

Heavy Rainfall Events. The heaviest theoretical rainfalls for the United States have been calculated using real data as input for mathematical rainfall models (Hershfield 1961). These calculations indicate that any point in the Eastern Powder River Basin has a 100-year mean recurrence interval for a rainfall rate of 1.7 inches in a 30-minute period. Rainfalls of this intensity occur at an average frequency of once every 100 years. Similarly, 24-hour rainfalls of 4.0 inches can be expected once every 100 years.

Climatological records indicate that the heaviest 24-hour precipitation total ever recorded in Wyoming occurred at Dull Center (in the region). This record precipitation amount was 5.50 inches on May 31, 1927 (National Oceanic and Atmospheric Administration 1974).

Floods. Occasionally flooding occurs in the region. Normally, any flooding coincides with the spring snow melt. When the melting of the snowpack coincides with heavy rains, the region experiences its most severe flooding.

Droughts. Historical data indicate a 1-year drought frequency of once every 7 years, a 2-year drought frequency of once every 25 years, and a 3-year drought frequency of once every 143 years. These results were derived from statistical analysis of long-term data for Douglas, Gillette, and Dull Center. Probabilities and mean recurrence intervals (average frequencies) were calculated for 1 year, 2 consecutive years, and 3 consecutive years with 75% of normal annual precipitation.

The frequency of droughts is an important consideration in the determination of revegetation success. Annual rainfall totals can be used as general indicators of drought conditions. Since hydrological imbalances denote drought conditions, subnormal precipitation totals can indicate probable drought conditions that may cause failure of revegetation attempts. Drought conditions may develop whenever a certain location receives less than 75% of its normal precipitation (*Texas Almanac* 1975).

Thunderstorms, Hailstorms, Tornadoes. Locations in the Eastern Powder River Basin are likely to experience 38 days a year on which thunderstorms occur (Landsberg 1969). In comparison, the most thunderstorm days in Wyoming, 45 per year, occur over the southeastern portion, while the northwestern portion of the state has only 35.

Ten percent of the thunderstorms in the region may produce hail (Flora 1956). Hail in the region is not unusual. The region experiences hail 3 days per year in the northern and southern portions and 2 days per year in the central portion (Changnon 1977). The hailstorms in Wyoming are most frequent between 2:00 p.m. and 3:00 p.m. in June and July.

Tornadoes are not very frequent and are usually rather small. The probability and average frequency for a tornado to strike any given point in the Eastern Powder River Basin were calculated from tornado occurrence records (U.S. Department of Commerce 1969) and by a prescribed method (Thom 1963). A tornado can be expected at any given point in the region only once every 3,000 years. In contrast, a point in central Oklahoma can be expected to suffer the effects of a tornado once every 275 years.

Air Moisture Statistics

The annual average relative humidity ranges from 55% to 60% over the region. The most humid months are usually November, December, and January, during which the relative humidities average 65% to 70%. The lowest monthly average relative humidity occurs in August when the daily relative humidities average only 45% to 50%. Generally, relative humidities are highest near sunrise, when the coolest temperatures normally occur, and lowest in mid-afternoon, when the tempera-

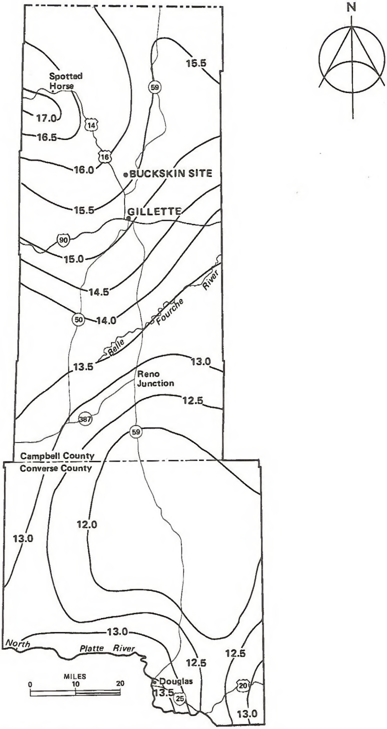
TABLE R2-3

REPRESENTATIVE MONTHLY AND ANNUAL PRECIPITATION
NORMALS FOR THE EASTERN POWDER RIVER BASIN
(1931-1955)

(Inches)

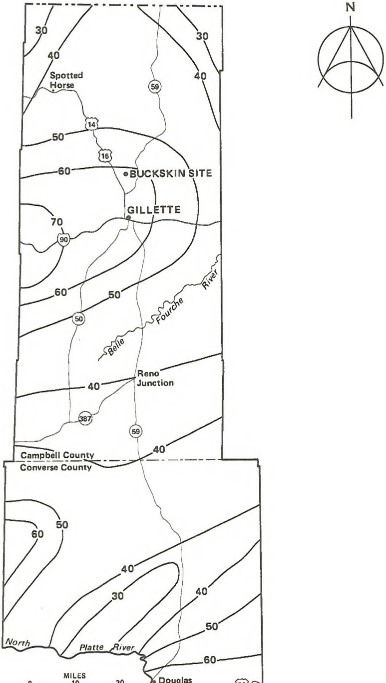
	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL
Gillette	0.70	0.50	1.15	1.71	2.31	2.51	1.27	0.86	1.17	0.72	0.73	0.64	14.27
Dull Center	0.27	0.27	0.55	1.55	2.37	2.24	1.45	1.47	0.98	0.88	0.42	0.29	12.74

Source: National Oceanic and Atmospheric Administration 1974



SOURCE: NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION, 1974. UNITED STATES DEPARTMENT OF COMMERCE, 1955 - 1975

Figure R2-1
ANNUAL PRECIPITATION TOTALS IN INCHES, 1931 - 1975



SOURCE: UNITED STATES DEPARTMENT OF COMMERCE, 1954 - 1975.

Figure R2-2
ANNUAL SNOWFALL IN INCHES, 1954 - 1975

tures are usually the highest. The average daily range of relative humidities is from about 45% in the afternoon to about 70% in the early morning (National Oceanic and Atmospheric Administration 1974).

Fog does not often cause significant reduction of the visibility in the region. Fogs occur infrequently in northeastern Wyoming because of the low amount of moisture normally available for condensation in the air near the ground. Depending on the location within the region, there are 5 to 10 days a year on which horizontal visibilities of ¼ mile or less are reported (National Oceanic and Atmospheric Administration 1974). Fogs occur most frequently during the spring and fall and least frequently during the summer.

The mean annual evaporation from a large body of water, such as a lake, is about 42 inches in the region. The mean annual Class A pan evaporation rate for the region is approximately 60 inches per year (U.S. Department of Commerce 1968).

Sunshine

In the Eastern Powder River Basin, an average of 2,840 hours of sunshine are recorded during the year. This represents 63% of the possible sunshine during the year. The month of July receives the most sunshine while the November-December period receives the least.

Visibility Related to Precipitation, Fog, and Haze

Visibility in the region is quite good because of the dry air which prevails. The annual average visibilities range from approximately 35 to 45 miles. Visibilities average about 30 miles during the early spring and about 50 miles during the summer. Visibilities lower than 1 mile are infrequent; however, visibilities greater than 60 miles are fairly common. The primary restrictions to visibility are precipitation, fog, and haze. Visibilities are normally highest in the afternoons (1) when the relative humidity is lowest, (2) when any low-level fog or haze has dispersed, (3) when the air is well mixed, and (4) when the wind speeds are strongest.

Visibility Related to Atmospheric Particulate Concentrations

The data from measurement of total suspended particulate (TSP) concentrations by high-volume samplers is the only instrument-based indicator available to estimate horizontal visibilities. An empirical relationship between horizontal visibilities and TSP concentrations has been established by a study done at the Los Alamos Scientific Laboratory (Ettinger and Royer 1972). Applying the empirical function to the regional baseline TSP concentration of 24 micrograms per cubic meter ($\mu g/m^3$), the annual average visibility for the region is 54 miles. That is, the mean visibility is 54 miles in the areas of the region where the air quality is not affected by surface mining or by urban areas.

Visibilities of 7 miles or less caused by dust, blowing dust, or blowing sand are expected less than 1 hour per year in the Eastern Powder River Basin (Orgill and Sehmel 1976). The frequency of dusty conditions in Wyoming is negligible compared to the rest of the contiguous United States. The highest annual frequency of dusty conditions occurs at Lubbock, Texas, where 263 hours per year are expected to have dusty conditions.

Wind Patterns

An annual wind rose for Moorcroft, Wyoming, is presented in Figure R2-3. The large-scale wind patterns are significantly modified by the terrain in and surrounding the region; thus, no uniform flow exists over all the region. On a large-scale basis, the Moorcroft wind patterns are affected by the Big Horn Mountains to the west of the region and by the Black Hills to the east.

At about 10,000 feet above sea level, the wind patterns over the Eastern Powder River Basin show the wind blows predominantly from the west through northwest directions. This information was gained from upper-level meteorological data for Glasgow, Montana, and Rapid City, South Dakota (National Climatic Center 1972-1975). Those cities are the locations of the most representative atmospheric sounding stations near the region.

The annual wind rose for Moorcroft shows that south-southeasterly (SSE), south-southwesterly (SSW), and northerly (N) winds are most prevalent. This wind pattern is partially caused by the low-level blocking and deflecting of the prevailing westerlies by the Black Hills, which are east of Moorcroft. The frequent N and north-northwesterly (NNW) winds at Moorcroft are most often associated with the movement of cold air masses across the region.

The Moorcroft wind rose shows approximately the same percentage of SSE winds for each of the four seasons of the year. Except for winter, SSE winds prevail. During the winter, SSW winds prevail, although SSE winds are almost as common. Winds from the combined N and NNW sectors show a predominance during the spring.

Wind speeds are often high in the region because of the vast stretches of open, unforested land. The respective annual average wind speeds at Casper, Douglas, and Moorcroft for certain periods of record are 13.1 miles per hour (mph), 12.5 mph, and 9.2 mph (National Climatic Center 1970-1974, 1948-1954, 1950-1952, respectively). Differences of annual average wind speeds among the locations are largely caused by the effects of local features of topography such as river valley orientations.

Wind speeds are highest during the winter and spring, when large-scale weather systems are strongest. During the winter, wind gusts frequently reach 30 to 40 mph, with occasional higher gusts (National Oceanic and Atmospheric Administration 1974). Winds are lightest during the summer. Once every 100 years a 95-mph sustained wind can be expected in the region, while once every 50 years an 85-mph wind can be expected (Thom 1968).

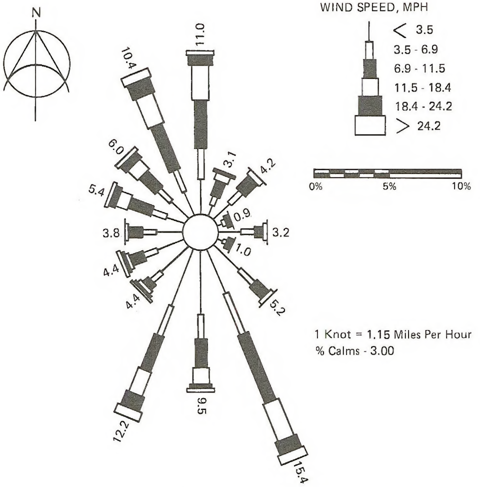


Figure R2-3
ANNUAL WIND ROSE FOR MOORCROFT, WYOMING
1950-1951

Pollution Dispersion Potential

General Characteristics

The pollution dispersion potential is an indicator of the ability of the atmosphere to disperse or dilute air pollutants and is related to air ventilation. In general, a high pollution dispersion potential (high ventilation) is desirable, since it lowers the pollution concentrations that can be expected at the ground level. The pollution dispersion potential for the Eastern Powder River Basin is somewhat worse than the average dispersion potential for the contiguous United States. Approximately two-fifths of the United States has worse dispersion potential than the region. The ventilation values in Table R2-4 show that the pollution dispersion potential is highest during the spring and summer.

Topographic Influences

Figure R2-4 shows airshed areas in the region which might represent problem areas with respect to pollution. These airsheds are often characterized by steep-sided valleys or canyons. These areas often have lighter winds and lower mixing heights than surrounding regions because of (1) the sheltering effect of the valley walls, and (2) cold air drainage down the valley slopes. The accumulation of the cold air in the valleys produces stronger, deeper, and more persistent temperature inversion layers that limit mixing of the air.

AIR QUALITY

Introduction

The 1970 Clean Air Act Amendments established primary and secondary national ambient air quality standards for six pollutants: total suspended particulates (TSP), sulfur dioxide, nitrogen dioxide, carbon monoxide, photochemical oxidants (ozone), and hydrocarbons. These standards are discussed in detail in Chapter 3. The primary standards were set to protect the public health, while the secondary standards were set to protect the public welfare.

The Eastern Powder River Wyoming Basin, Campbell and Converse counties, is meeting the national standards for all "criteria"pollutants (U.S. Environmental Protection Agency 1978). All of the Wyoming air quality standards are also being met. The prevention of significant air quality deterioration (PSD) regulations, which apply to all areas meeting the national ambient air quality standards, are applicable to the Eastern Powder River Basin. PSD regulations are further discussed in Chapter 3.

Existing Air Quality

Total Suspended Particulates

The TSP monitors used to characterize the regional air quality are listed in Table R2-5. Monitors with less than a complete year of data are included in the table as an indicator of the 24-hour concentrations expected in portions of the region. Monitors that were sited to assess the air quality impact of specific emissions sources are not included in the table, since these monitors are not representative of the regional air quality. At a few of these monitors, the national and state standards have been exceeded.

The measured TSP concentrations at Casper, Douglas, and Gillette are well below both the national and state ambient air quality standards. Annual geometric means at these urban sites range from 30 micrograms per cubic meter ($\mu g/m^3$) at Gillette to 51 $\mu g/m^3$ at Casper. These concentrations are well below the national secondary and Wyoming ambient air quality standard of 60 $\mu g/m^3$. The 10 $\mu g/m^3$ annual concentration recorded for Gillette is for a monitor at a rural site 7 miles south of town. TSP concentrations monitored at the site are not expected to be representative of the TSP concentrations of the downtown area of Gillette. Second highest 24-hour concentrations in the urban areas range from 74 $\mu g/m^3$ at Douglas to 150 $\mu g/m^3$ at Gillette. The 24-hour TSP concentration at Gillette equals the federal secondary and Wyoming ambient air quality standard of 150 $\mu g/m^3$.

The annual TSP concentrations at undeveloped rural sites are less than half of the national secondary and Wyoming ambient air quality standards. The annual TSP concentrations vary from 11 $\mu g/m^3$ at the proposed Buckskin Mine site to 29 $\mu g/m^3$ at the planned coal gasification plant site. The second highest 24-hour concentrations are also less than the standards. The second highest 24-hour concentrations range from 43 $\mu g/m^3$ at the Pronghorn Mine between Gillette and Reno Junction to 131 $\mu g/m^3$ at a site nearer Reno Junction.

Gaseous Pollutants

Sulfur dioxide (SO_2) monitoring data are available for only two towns in or near the region: Gillette and Casper. The Gillette site also has the only nitrogen dioxide (NO_2) monitor in the region. The only photochemical oxidant monitor was installed at Douglas in late 1977. Carbon monoxide is not monitored in Wyoming.

The limited SO_2 and NO_2 sampling data indicate that existing regional concentrations are low. Annual SO_2 concentrations range from 4 $\mu g/m^3$ at Casper in 1976 to 11 $\mu g/m^3$ at Gillette in 1974-1977. These concentrations are well below the 60 $\mu g/m^3$ Wyoming standard. Maximum 24-hour SO_2 concentrations were also well below the 260 $\mu g/m^3$ Wyoming standard. Gillette had an 11 $\mu g/m^3$ maximum 24-hour concentration in 1974-1975, a 6 $\mu g/m^3$ maximum in 1976, and a 1 $\mu g/m^3$ maximum in 1977, while Casper had a 15 $\mu g/m^3$ 24-hour concentration in 1974-75, an 18 $\mu g/m^3$ maximum in 1976, and a 23

TABLE R2-4

DISPERSION CONDITIONS IN THE EASTERN POWDER RIVER BASIN

Season	Mixing Height (Meters), (Feet) Morning		Afternoon		Transport Wind Speed (Meters/Second), (Miles/Hour) Morning		Afternoon		Ventilation* ($Meters^2$/Second), ($Feet^2$/Second) Morning		Afternoon	
Winter	300	984	1,000	3,281	5.8	13.0	6.8	15.2	1,740	18,729	6,800	73,195
Spring	400	1,312	2,400	7,874	6.0	13.4	8.1	18.1	2,400	25,833	10,440	209,250
Summer	300	984	2,800	9,186	4.2	9.4	6.6	14.8	1,260	13,563	18,480	198,917
Fall	290	951	1,700	5,577	4.9	11.0	7.0	15.7	1,570	16,899	11,900	128,090
Annual	320	1,050	1,090	6,234	5.2	11.6	7.1	15.9	1,720	18,514	13,490	145,205

Source: Holzworth 1972
Note: Period of Record: 1960-1964
* Ventilation equals mixing height times transport wind speed.

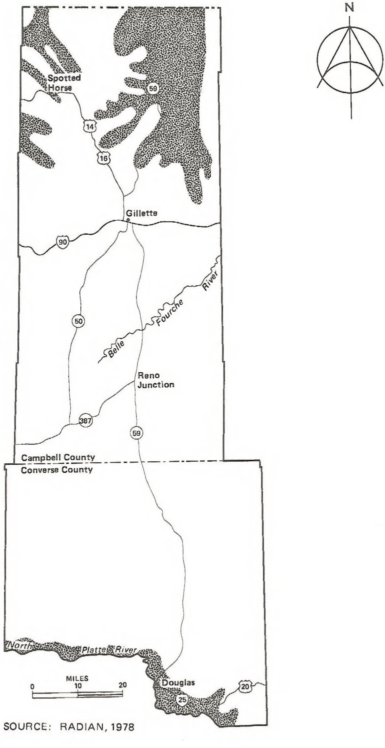


Figure R2-4
AIRSHEDS IN THE EASTERN POWDER RIVER BASIN

TABLE R2-5

SUMMARY OF TOTAL SUSPENDED PARTICULATES (TSP) MONITORING DATA

MONITORING LOCATION	SAMPLING PERIOD YEAR	MONTHS	NUMBER	CONCENTRATIONS ($\mu g/m^3$) AGM*	2ND MAX**
URBAN					
Gillette	75	Jan-Aug	27	IS****	150
	75-76***	Sep-Sep	64	10	46
Casper	76	Jan-Dec	54	51	156*****
Douglas	75	Jan-Dec	60	33	74
	76	Jan-Dec	--	30	NA
RURAL-NORTH					
Rawhide	75-76	Jul-Jun	--	27	81
Rawhide 2	75-76	Jul-Jun	--	18	51
East Gillette	76-77	Apr-Mar	54	18	44
Eagle Butte 1	76-77	Jun-Apr	58	IS	87
Eagle Butte 2	76-77	Jun-Apr	54	IS	71
Buckskin 1	76-77	Mar-Feb	52	11	44
Buckskin 2	76-77	Mar-Feb	55	12	44
Reno Junction	75	Jan-Dec	52	22	131
	76	Jan-Dec	54	19	90*****
Pronghorn	75-76	Dec-Jun	27	IS	43
Gordon Ranch	75	Jan-Dec	59	26	84
Stoddard Ranch	75	Jan-Jun	23	IS	30
Irene Ranch	75	Feb-Aug	23	IS	75
Panhandle E.	75	Jan-Dec	52	29	72
	76	Jan-Sep	37	IS	51

Sources: Schick undated, Radian 1977, PEDCo 1976, Metronics 1975

* AGM--Annual geometric mean (comparable to National Ambient Air Quality Standards)

** 2ND MAX--Second highest 24-hour concentration

*** Monitor moved 7 miles south of town

**** IS--Insufficient sampling period to compute AGM

***** Highest 24-hour concentration--second highest not available

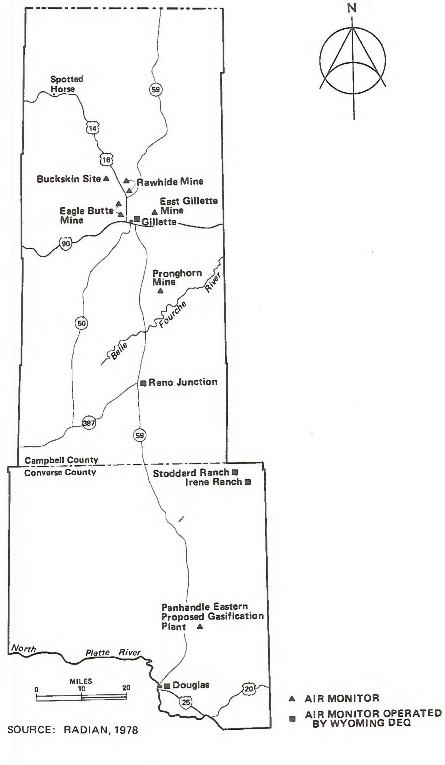


Figure R2-5
LOCATIONS OF AIR MONITORS IN CITIES AND UNDEVELOPED RURAL AREAS

$\mu g/m^3$ maximum in 1977. The annual NO_2 concentrations of 3 $\mu g/m^3$ in 1974 and 4 $\mu g/m^3$ in 1977 measured at Gillette are well below the federal and Wyoming standards of 100 $\mu g/m^3$.

Photochemical oxidant concentrations are assumed low in the region because of the small amounts of precursor hydrocarbon emissions (U.S. Environmental Protection Agency 1977). A photochemical oxidant monitor was located at Douglas in late 1977, and measurements are well below the standards. Existing ambient carbon monoxide concentrations are also assumed to be low because of the small amounts of carbon monoxide emissions. Most violations of carbon monoxide standards occur in large, densely populated urban areas of the nation.

Baseline Concentrations

Baseline concentrations of TSP were estimated by examining air quality data representative of the region. Two monitors operated by the Wyoming Department of Environmental Quality and eight privately operated monitors provided acceptable data to calculate a baseline TSP concentration. For additional information see the Technical Report for Chapter 4 of the regional analysis on file at the Bureau of Land Management Casper District Office. The average of the concentrations measured at these sites is 24 $\mu g/m^3$ and is used as an annual baseline concentration.

Annual average SO_2 and NO_2 concentrations were only monitored near towns in the region. Therefore, rural air quality data from areas similar to the region were used to estimate baseline concentrations of SO_2 and NO_2.

Based on air quality data for Rock Springs, Wyoming (U.S. Environmental Protection Agency 1976), an annual average background concentration for SO_2 would be approximately 3 $\mu g/m^3$. Similar data were not available for Wyoming for estimating background NO_2 concentrations. However, a rural monitoring site in Rosebud County, Montana, reported an annual concentration of 9 $\mu g/m^3$ for NO_2. Accordingly, an annual average background NO_2 concentration of 9 $\mu g/m^3$ is assumed to be representative for the Eastern Powder River Basin.

TOPOGRAPHY

The Eastern Powder River Basin is located on the gently (generally less than 2 degrees) southwest-dipping, east flank of the Powder River Basin, the largest intermountain basin in Wyoming. The latter is both a structural and topographic depression about 250 miles long and more than 100 miles wide. It is characterized in the northern part by relatively high, open, rolling hills with 500 to 1,000 feet of topographic relief, and in the southern part by plains and tablelands with moderate topographic relief of 300 to 500 feet (Keefer 1974).

The topography is controlled mainly by geology and climate. The essentially flat-lying beds of clay, silt, and sand erode easily, whereas harder beds of scoria (clinker) and massive sandstone are left as rough, hummocky escarpments, ridges, knobs, and buttes.

The Eastern Powder River Basin is drained by the Powder and Little Powder rivers in the northern part, by Donkey Creek and the Belle Fourche River in the east central part, and by the South Fork of the Cheyenne River and Lance Creek in the southeastern part. The North Platte River forms the southern boundary of the region. The larger streams are well entrenched with broad, flat floodplains bordered by alluvial terraces. Many of the smaller drainages also contain alluvium which is too small to show at the scale of the geologic map (Map 9, Appendix A).

Elevations in the region range from about 3,400 to over 6,000 feet. From Gillette north, the region is characterized by relatively high, rounded hills. Badlands topography is found throughout the area adjacent to major drainages, but especially west and northwest of Gillette in the Powder River drainage. Here narrow drainages with steep gradients (slopes) are divided by steep, narrow ridges. South of Gillette, the topography changes to gently rolling plains with occasional erosional remnants and broad stream valleys.

Where coal beds are exposed, the coal has commonly burned to some extent, baking the overlying rock into erosion-resistant scoria deposits. The most extensive of these is associated with the Wyodak seam along the eastern edge of the region, where it forms buttes and escarpments (the Rochelle Hills) marking the eastern limit of coal development. Pumpkin Buttes, which rise to an elevation of over 6,000 feet, is a conspicuous topographic feature in southwestern Campbell County.

The general physiographic setting of the Eastern Powder River Basin of Wyoming is shown in Figure R2-6.

GEOLOGY

Stratigraphy

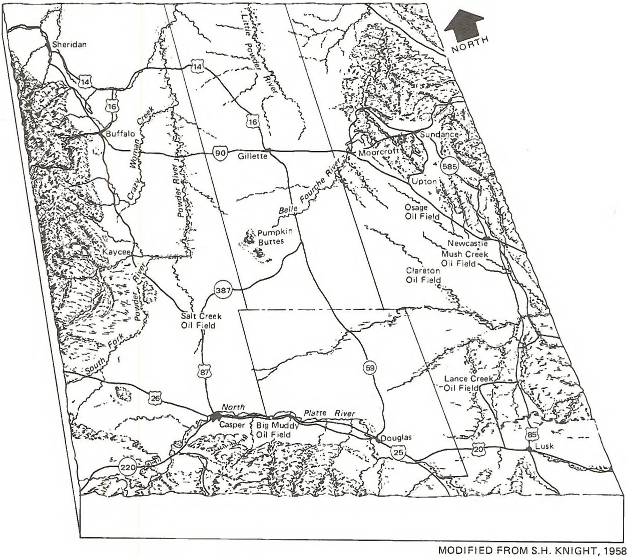
The Eastern Powder River Basin contains a rock sequence ranging in age from Precambrian to Recent.

A brief lithologic description of the formations exposed in the region as well as those present in the subsurface is given on Figure R2-7.

Coal-Bearing Formations

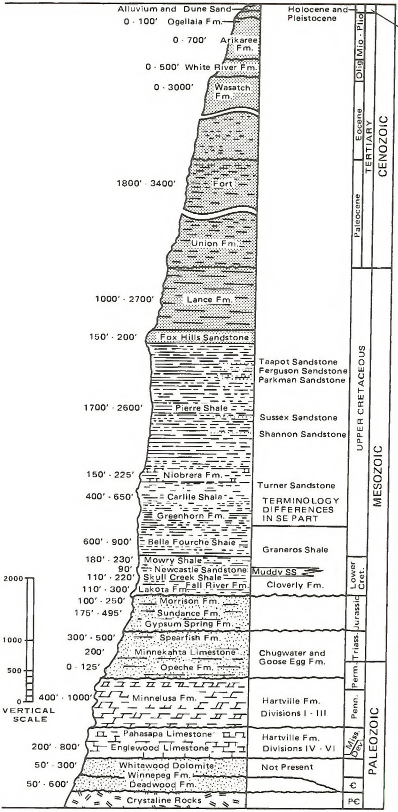
The Fort Union and Wasatch formations contain the only commercial coal beds in the region, although the lower half of the Lance Formation contains some thin coal beds.

The Fort Union Formation is made up of three members: the Tullock (lowest), the Lebo (middle), and the Tongue River (uppermost). This distinct threefold subdivision can be mapped with certainty only in the northern part of Campbell County (Map 9, Appendix A). The Tongue River Member is not recognized in the southern



MODIFIED FROM S.H. KNIGHT, 1958

Figure R2-6
PHYSIOGRAPHY OF THE POWDER RIVER BASIN



Holocene end Pleistocene - Unconsol idated clay, silt, and, and gravel

Ogallala Fm. - 0' - 100' of calcareous claystone, siltstone, sandstone and conglomerate beds

Arikarea Fm. - 0' - 700' of light gray tuffaceous sandstone and silt-stone, with limestone and conglomerate

White River Fm. - 0' - 500' of vari-colored tuffaceous claystone, siltstone, and sandstone with lenticular conglomerate near base

Wasatch Fm. - 0' - 3000' of buff arkosic sandstone, lenticular conglomerate drab siltstone, carbonaceous shale, and many coal beds

Fort Union Fm. - 1800' - 3400' of drab sandstone, siltstone, and shale with numerous coal beds

Lance Fm. - 1000' - 2700' of dark gray shale and yellowish-brown sandstone

Fox Hills Ss - 150' - 200' of light gray sandstone and sandy shale

Pierre Sh. - 1700' - 2600' of dark gray marine shale end claystone with siltstone, sandstone, limestone, and bentonite beds

Cloverly Fm. - 110' - 300' of inter-beddad light grey sandstone and variegated bantonitic claystone with lenticular chert pebble conglomerate

Morrison Fm. - 100' - 250' of var-iegeted claystone with nodular limestone and silty sandstone lanses

Sundance Fm. - 175' - 495' of red, gray and greenish-gray snadstone and shale

Chugwater Fm. - 300' - 500' of red silt-stona and shala with anhydrite, gypsum and sandstone seams

Goose Egg Fm. - 200' of red shale and siltstone containing gypsum, anhydrite, and sevaral gray lime-stone beds

Division I - 175' of bluish-grey lime-stone with red, gray, and purple siltstone and dolomitic siltstone

Division II - 225' of light-colored, chalky dolomita and bluish-gray limestone

Division III - 250' of sandstone, shale, dolomite, and braccia bads

(See also Map 9, Appendix A)

Figure R2-7

COLUMNAR SECTION OF ROCK SEQUENCE IN THE EASTERN POWDER RIVER BASIN AND DESCRIPTION OF EXPOSED FORMATIONS

part of the region. The top of the Wyodak coal bed marks the top of the formation along much of its eastern outcrop in the region. Numerous other coal seams are present both above and below the Wyodak (Figure R2-8).

The thickest coal in the Wasatch Formation is the Felix seam about 200 feet above the base. Thinner seams are present both above and below the Felix (Figure R2-8).

Aquifers

The Fox Hills, Lance, Fort Union, and Wasatch formations and Quaternary alluvium are shallow aquifers in that part of the region affected by mining. Deep aquifers present in the subsurface which will be affected by mining are the Madison Limestone and its eastward equivalent, the Pahasapa Limestone. These aquifers are discussed in more detail in Chapter 2, Water Resources.

Structure

Structurally, the basin is a broad, asymmetric syncline with the steep limb to the west (Figure R2-9). Structural relief on top of the Dakota Sandstone (a horizon about 250 feet above the base of Cretaceous rocks in Figure R2-9) ranges from a high point of 5,000 feet above sea level in the southwestern part of Johnson County to a low point more than 10,000 feet below sea level in west central Converse County. Total relief is more than 15,000 feet. Structural relief on the base of the Fort Union Formation is about 6,000 feet, and on the base of the Wasatch Formation is only about 3,000 feet.

Geologic Hazards

Major faults are not known to offset rocks in the Eastern Powder River Basin of Wyoming, but faults with only small displacements are present in northern Campbell County (Map 9, Appendix A).

The region is aseismic (no tendency for earthquakes) except for a small area in the southwest corner, which is rated as an area of "lesser seismicity"(VII or greater on the modified Mercalli scale, or 5.0 or greater on the Richter scale with a frequency of one or fewer earthquakes per decade) (Simon 1972). Two earthquakes are recorded in this area of "lesser seismicity"in the general vicinity of Casper, Wyoming, one in 1894, and one in 1897 (ibid.).

At present coal mine reclamation has resulted in reduced ground stability to depths of about 60 to more than 400 feet over an area of 1,234 acres in the region.

Paleontology

To date, only a limited number of paleontological surveys have been conducted in the region, with most attention being given to fossil vertebrates. A general summary of the fossil-bearing formations, ages, number of known fossil localities, and general fossil types in the region is presented in Table R2-6.

SOILS

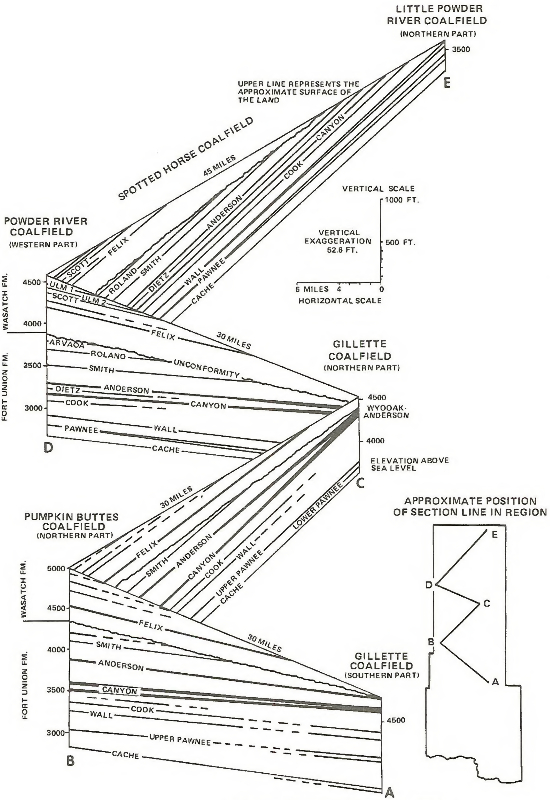
Detailed-reconnaissance progressive soil surveys are currently being conducted by the Soil Conservation Service (SCS), U.S. Department of Agriculture (USDA), in both Campbell and Converse counties. Most of the Thunder Basin National Grasslands has been mapped using the new soil taxonomy. Most of the remainder of the two counties has not been mapped using the new soil taxonomy at this date (June 1978), but has been soil mapped using older classification systems such as the USDA 1938 Soil Classification System (Baldwin et al. 1938).

In order to express soil location within the basin, a soil association map (Map 4, Appendix A) was prepared from existing SCS generalized county soil maps. The original maps were prepared over a period of several years by different personnel using soil classification systems of the great soil groups (ibid.), 7th approximation (USDA 1960), and new soil taxonomy (USDA 1975). The compiled soil association map of the Eastern Powder River Basin was correlated using existing information dating back to 1953 and yet interpreted according to modern classification concepts. This identifies an element of questionable accuracy in the basic soil association map.

Soil associations are basically groupings of two or more distinctive kinds of soil that occur together in the landscape in some regularity of pattern but may be very different in characteristics or capabilities. Soil associations are named according to the dominant soils within the associations. For example, an association may contain ten known soil series, but be named for only the three major soils. Consequently, minor soils which may be significant to management are not considered in the map unit description or in the interpretative evaluations. (Quantitative evaluations of the map units are impossible since major series may differ widely in characteristics. Individual evaluations of the component major soil series have limited value since the percent composition within the unit is unknown.)

Appendix B, Soils, includes: soil association descriptions; a table of soil interpretations for regional soil associations which provides the physical, chemical, and management interpretations for the soil series included in each soil association (Table RB-1); and tables of soil series descriptions which provide estimated physical, chemical, and behavior characteristics. Map 4, Appendix A shows soil associations of the Eastern Powder River Basin.

The suitability of the major regional soil series for mined land reclamation material is one of the interpretations on Table RB-1. Until the progressive soil surveys of Campbell and Converse counties (currently being con-



SOURCE: BRECKENRIDGE ET AL. 1974

Figure R2-8
CORRELATION AND THICKNESS OF MAJOR COAL SEAMS

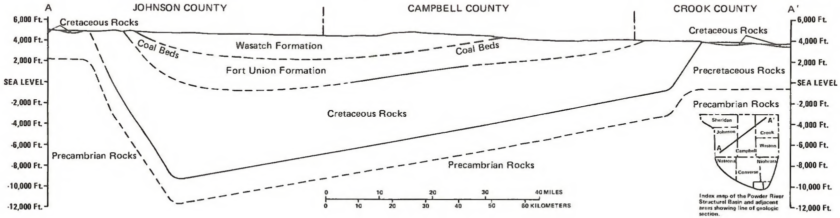


Figure R2-9
GENERALIZED GEOLOGIC SECTION OF THE POWDER RIVER BASIN AND ADJACENT AREAS, NORTHEASTERN WYOMING

TABLE R2-6

SUMMARY OF FOSSIL LOCALITIES IN EASTERN POWDER RIVER BASIN

Formation	Period	Known Fossil Localities	Type of Fossils*
Surficial Deposits	Quaternary	General**	I
		1	V (mammal)
	Tertiary		
Ogallala	Miocene and Pliocene	0	
Arikaree	Miocene	General	I, V, P
White River	Oligocene	1	V (mammal)
		General	I, V, P
Wasatch	Eocene	3	V (mammal)
		1	V (fish)
		General	I, P
Fort Union	Paleocene	4	P (pollen)
		11	P (leaves)
		General	I, V (lower vertebrates)
		0	V (mammals)
Lance	Late Cretaceous	General	I, V, P
Fox Hills	Late Cretaceous	General	I, P
Pierre	Late Cretaceous	General	I, V
Cloverly	Early Cretaceous	General	I, P
Morrison	Jurassic	General	I, V, P
Sundance	Jurassic	General	I
Chugwater	Triassic	General	I, V
Goose Egg	Permian and Triassic	General	I, V

TABLE R2-6
(cont'd)

SUMMARY OF FOSSIL LOCALITIES IN ES REGION

Formation	Period	Known Fossil Localities	Type of Fossils*
Hartville			
Division I	Permian (?)	G	I
Division II and III	Pennsylvanian	G	I

* I = Invertebrate
V = Vertebrate
P = Paleobotanical

** Formation contains fossils throughout, no specific localities identified.

ducted by the SCS) are closer to completion, it will not be possible to state a regional acreage figure for the major soil series present. However, based on experience up until this time, we can reasonably expect a greater acreage of the less suitable soils for reclamation purposes to be present in the region than of the most suitable soils.

Soil Formation

Soils of the region have developed mostly with shortgrass vegetative cover common to the semiarid Great Plains. Due to prevailing climate and vegetative conditions, organic matter is accumulated slowly, and soils have developed with light-colored surfaces. Subsoil colors are normally light brown or reddish brown, and are often influenced by white, powdery, lime-carbonate accumulations caused by low rainfall and insufficient leaching. Soils of the region are mostly residual (developed in place), and formed from weathered sedimentary bedrock, mostly sandstone and shale.

On gently rolling uplands, bedrock is usually not more than 36 inches below the surface; on more rolling lands the depth to bedrock is about 20 to 30 inches; and on steep slopes, only a few inches of soil or soil material overlie the partly weathered bedrock. Rock outcrops are common on the steepest slopes.

To a marked degree, developed soils reflect the character of the bedrock. Areas of sandy and medium-textured friable (crumbling naturally) soils are underlain by sandstone and sandy shale, and heavy clay soils are underlain by clayey shale.

The sandy loam and loam soils absorb moisture readily. They are thicker than the heavy, or fine-textured soils. Surface layers are well supplied with organic matter and are neutral or only slightly alkaline. Subsoils are friable or only moderately compact. Lower subsoils are calcareous and are represented by a lime-carbonate accumulation zone at depths of 16 to 30 inches.

The gray, heavy clay shale weathers slowly, and the soils developed from it are shallow. These shallow soils have a medium to fine-textured surface and a dense or compact subsoil. They absorb moisture slowly, and runoff is rapid on sloping areas. On steep slopes, little or no soil development has taken place due to geological erosion. Level areas within the gently undulating or rolling uplands are characterized by a microrelief of small hummocks and depressions with salty spots. These soils are mostly neutral to slightly alkaline. The zone of lime-carbonate accumulation may be weakly developed or absent.

Scoria (clinker) gives rise to brown or reddish brown, medium-textured, shallow, gravelly, and rocky soils.

Miscellaneous areas include rough, broken land, rockland, gullied land, and shale/rock outcrops occupying lands of steep relief. A complex residual soil pattern occurs between the outcrops and ridges. These soils are not classified.

Alluvial soils are developed from a variety of material washed from the uplands and high landscapes and deposited along stream courses. They occupy comparatively narrow, elongated, continuous or broken strips along most of the main drainages. The soils have a grayish brown to dark grayish brown friable surface that contains a fair amount of organic matter, and they are calcareous at or near the surface. Soluble salts in varying quantities are present in some of these soils.

Management problems associated with soils of the Eastern Powder River Basin are strongly related to the climatic and geological setting. Vegetation is sparse due to the short growing season and low precipitation; the productive capacity ranges from 200 pounds per acre on rough, broken lands to 3,000 pounds per acre on bottomland. The wind and water erosion hazard increases from medium to very high if vegetation is removed and topsoil disturbed. Runoff water is generated from slopes having poor vegetative cover since physical properties of the soil do not allow adequate infiltration or moisture storage. The moisture is lost in runoff that carries along sediment and soluble salts to be deposited in low areas, along streams, or to remain suspended in water systems, thereby lowering the quality of this water.

In addition, soils of the region are easily compacted and highly susceptible to shrinking when dry or swelling when wet. These factors, coupled with low infiltration and permeability rates, increase the hazard for erosion, reduce revegetation success, increase water runoff and flooding, and limit the soils' suitability for reservoirs and as a source of topsoil or construction material.

The most common natural soil problems of the area are (1) clayey textures (having high shrink-swell potentials, low infiltration rates, slow permeability, and poor plant-soil moisture relationships); (2) high wind and water erosion hazards (due to poor ground cover interrelated to slope, soil texture, sedimentary parent materials, short growing seasons, and low available soil moisture); and (3) high levels of soluble salts detrimental to plant growth (concentrated due to ponded water from runoff, high evapotranspiration rates, poor leaching related to slow permeability, and exposed saline and alkaline shales).

Land Capability is defined as the suitability of land for use without permanent damage. Land capability, as ordinarily used in the United States, is an expression of the effect of physical land conditions, including climate, on the total suitability for use without damage for crops that require regular tillage, for grazing, for woodland, and for wildlife.

Land capability classification refers to groupings of soils into special units according to their capability for intensive use, and the treatments required for sustained use. Land capability classification involves consideration of (1) the risks of land damage from erosion and other causes, and (2) the difficulties in land use owing to physical land characteristics, including climate. This classification system has been prepared by the Soil Conservation Service (1973). The SCS recognizes eight classes of land according to the risk of land damage or the difficulty of land use; they are:

Class I. Soils that have few limitations restricting their use.

Class II. Soils that have some limitations reducing the choice of plants or require moderate conservation practices.

Class III. Soils that have severe limitations that reduce the choice of plants, require special conservation practices, or both.

Class IV. Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both. Generally the last soil grouping considered suitable for cultivated crops; requires major treatment.

Class V. Soils that have little or no erosion hazard but that have other limitations, impractical to remove, that limit their use largely to pasture, range, woodland, or wildlife food and cover.

Class VI. Soils that have severe limitations that make them generally unsuited for cultivation and limit their use largely to pasture or range, woodland, or wildlife food and cover.

Class VII. Soils that have very severe limitations that make them unsuitable to cultivation, and that restrict their use largely to grazing, woodland, or wildlife.

Class VIII. Soils and landforms that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply, or aesthetic purposes. Generally, Class VIII soils do not respond to management treatment within agricultural purposes.

Land capability classification has been in use by the SCS for a number of years in assisting landowners with their farm and ranch planning. Soil surveys are interpreted into capability groups and range sites (a range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its potential to produce native plants) according to production potentials and conservation treatment needs. The SCS maintains yield records on the performance of these groupings according to soil type within each land resource area.

The land capability and range site classification systems are nationally accepted methods for determining agricultural land potential. The systems provide established techniques for the description of existing land use potentials prior to major disturbance, such as mining.

Soil Investigation Specifications for Mining and Reclamation Proposals by Hayden D. Rounsaville (1976) describes means to link the existing land capability classification methods to predicted potentials and performance of reclaimed lands. Rounsaville's model is based on the assumption that the restored landforms and recreated soils perform like soils which occur naturally in the existing environment. This assumption has not been proved or disproved on mined land as yet due to the short time period that these systems have been applied to mined lands.

The process requires an assessment of the existing natural soils to determine how many acre-feet of suitable material are available for reclamation use. The assessment includes both physical and chemical properties. *Predicted classes* (according to capability classes and range sites) are based on the characteristics of the replaceable "topsoil,"the depth, and the slopes of the planned reformed land. Once these predicted classes have been established, the potential production performance can be derived from the normal SCS sources.

This evaluation technique not only describes existing potentials, but also provides quality standards for reclamation and a method to evaluate reclamation alternatives, indicating what uses are possible in reclamation, expected yields for cost-benefit evaluations, and management requirements for long-term sustained use.

The reclamation potentials displayed within the site-specific portion of this document were derived from the model described here.

WATER RESOURCES

Groundwater

The aquifers (water-bearing formations) described in this statement have been divided into three units. The lithology of formations comprising each unit is similar and, therefore, the water-bearing properties of the formations are similar. From oldest to youngest of these units are: (1) Bighorn Dolomite and Madison Limestone, (2) Fox Hills Sandstone and the Lance, Fort Union, and Wasatch formations, and (3) alluvium. The Madison Limestone is equivalent to the Pahasapa Limestone. The stratigraphic positions of these formations and brief lithologic descriptions are shown on Figure R2-7.

Bighorn Dolomite and Madison Limestone

The permeability of the Bighorn Dolomite and the Madison Limestone is the result of fracturing and solution that occurred after the formations were consolidated. This type of permeability differs greatly from place to place but yields of more than 1,000 gallons per minute (gpm) are available where cavernous (containing caves) and fractured zones are present. Of three wells tapping the Madison in the Midwest oil field at a depth of about 5,000 feet, one had an initial flow of 3,900 gpm with 150 pounds per square inch (psi) flowing pressure at the surface, a second well yielded 7,000 gpm with 179 psi flowing pressure at the surface, and the third yielded 4,750 gpm with unknown flowing pressure. Several wells in the Newcastle, Wyoming area have flows of more than 1,000 gpm from the Pahasapa at depths of about 3,000 feet. A well near Osage, Wyoming had an initial flow of about 800 gpm from the Pahasapa. A well about 30 miles north of Lusk, Wyoming, which did not penetrate cavernous or highly fractured material, yielded only 150 gpm with 330 feet of drawdown (Anderson and Kelly 1976). This yield was obtained only after the well was treated with acid to increase the yield. Konikow (1975) did a regional analysis of the Madison Limestone in the Powder River Basin. He concluded the regional transmissivity probably lies between 0.010 and 0.025 square feet per day (ft^2/day) and the storage coefficient probably ranges between 0.00001 and 0.00025. See Ap-

pendix B, Groundwater, for an estimation of well yield based on transmissivity.

Recharge to the Madison occurs on its outcrop from precipitation and runoff. The formation is exposed in the Big Horn Mountains, at the north end of the Laramie Range, and in the Black Hills. Some recharge is also believed to occur in the Hartville Uplift area where the Madison is exposed and where, because of the removal of overlying rocks by erosion, the Madison is overlain by water-bearing sand of Tertiary age. Recharge to the Madison Limestone in northeastern Wyoming was estimated to be 75,250 acre-feet per year (Wyoming State Engineer 1976).

Swenson and others (1976) state the configuration of the water level surface in the center of the Powder River Basin, an area which includes Campbell and northern Converse counties, is conjectural; however, they go on to state, "The relatively flat gradient implied in the central part of the basin could indicate either the quantity of underflow is small or the transmissivity is high"

There is one analysis of water from a well in the Madison in the region available. The well is in west central Converse County, Section 7, T. 34 N., R. 76 W., 6th P.M. The water from this well is a sodium-chloride type with a total dissolved solids content of 3,726 milligrams per liter (mg/l) (Hodson 1974).

The only use of water from the Madison Limestone in the area in 1977 was by the town of Douglas. The water is obtained from a spring southwest of Douglas and about 6 miles south of the region. Gillette has recently completed drilling a Madison well east of the region, but the well had not been tested as of August 1977.

Fox Hills Sandstone and the Lance, Fort Union, and Wasatch Formations

Most water wells in the Fox Hills Sandstone and the Lance, Fort Union, and Wasatch formations are either shallow stock or domestic wells or comparatively deep industrial wells. The stock and domestic wells are generally drilled only deep enough to obtain an adequate supply of water that is suitable in quality for the intended use. Therefore the formation developed depends on the well location, because the formations in general have a westward dip, and the highest altitudes are on the west side of the region. These stock and domestic wells are usually less than 1,000 feet deep and have yields in the order of 25 gpm. Industrial supply wells, most of which were drilled for water for secondary recovery of oil, are usually deeper than 1,000 feet; for some uses, the Office of the Wyoming State Engineer has, in the past, specified the water shall be from the deeper horizons to protect shallow supplies. These wells are often in the order of 3,000 to 5,000 feet deep and are open to two and sometimes three formations. No wells, however, are completed throughout single formations, thus differences in water-bearing properties between formations, and areal changes in water-bearing properties of a formation, are not known. All the available data from aquifer tests for these formations and the alluvium in the Eastern Powder River Basin are given in Appendix B.

Recharge to, and discharge from, the Fox Hills, Lance, Fort Union, and Wasatch is complex because the sandstone and coal aquifers in the unit are separated by shale of significantly lower permeability which impedes the vertical flow of water. The result is that there are large differences in the static head of water at different depths, and the movement of water is controlled by these differences. Because of the large number of aquifers that occur and the variation in topography, a large number of conditions are possible. Figure R2-10 shows two different hydrologic conditions that could occur with the same geologic and topographic conditions. The only difference between A and B is that the potentiometric surface in aquifer 2 indicates a recharge area in A and discharge area in B. A well drilled into aquifer 2 would have artesian flow in the one example but not in the other.

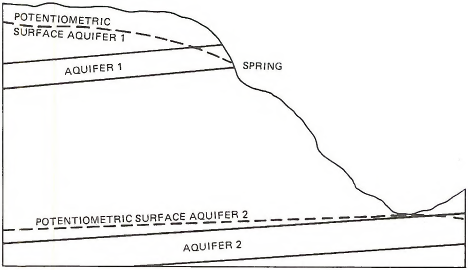
Recharge, if known, cannot be used without other information to determine the quantity of water that can be developed. Under natural conditions, recharge and discharge are in balance. New discharge points, such as wells, may for a time obtain all their water from storage in the aquifer; however, if discharge continues over an extended period, natural recharge will have to increase or natural discharge will decrease.

Where there are large differences in the static head at different depths such as shown in Figure R2-10, a potentiometric surface is meaningful only if it describes the static head along a specified surface or stratum. This data is available for the Wyodak coal in the area near the outcrop through the work done by the mining companies, and this data is summarized in Figure R4-11. Figure R2-11 shows the direction of movement of water at depth in the northern part of the area. Most of the water wells used for control points in drawing the figure are open to the Fox Hills Sandstone and several hundred feet of overlying sandstone. Therefore, the static head of water in the wells represents a composite of levels through a large, although not necessarily the same, interval.

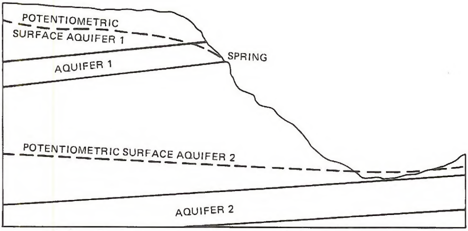
The movement of water in the overburden aquifer is controlled largely by the topography; therefore, the movement of water in the overburden is dominantly eastward.

Chemical analyses of 138 water samples from wells tapping the Fox Hills Sandstone and the Lance, Fort Union, and Wasatch formations in the region have been reported by Hodson (1971). The report shows the dissolved solids content of water ranges from 215 mg/l to 8,620 mg/l. Hodson and others (1973) state the dissolved solids content of water from most wells ranges from 500 mg/l to 1,500 mg/l.

The principal cations (positive ions) found in the water are calcium, magnesium, and sodium. The principal anions (negitive ions) are sulfate and bicarbonate. Riffenberg (1925) studied the quality of water in the northern Great Plains and found the water from shallow wells in the Lance and Fort Union formations was hard, and the less mineralized water was a calcium, or calcium-magnesium-sulfate type. Above about 700 mg/l, the sulfate and sodium increased in direct proportion to total dissolved solids.



(A)



(B)

Figure R2-10
EXAMPLES OF HYDROLOGIC CONDITIONS OCCURING IN THE REGION

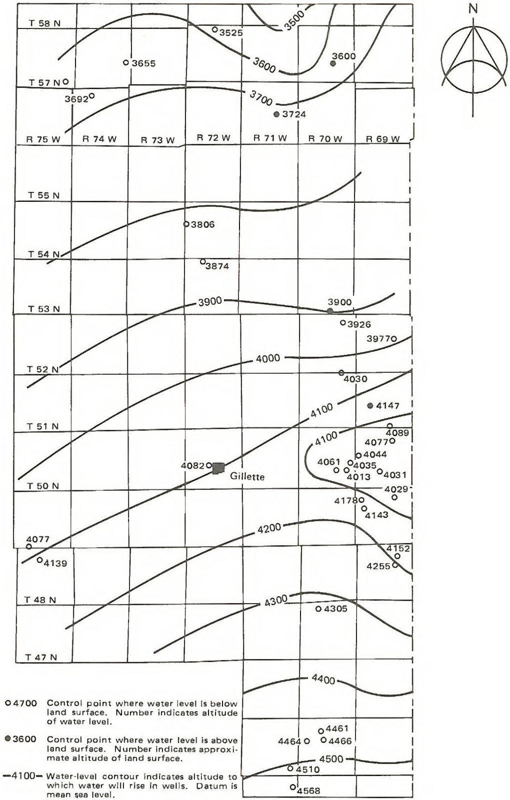


Figure R2-11

GENERALIZED MAP OF WATER LEVELS IN WELLS COMPLETED IN THE FOX HILLS SANDSTONE, LANCE FORMATION, AND LOWER FORT UNION FORMATION IN THE NORTHERN PART OF THE REGION

As the shallow water moves through the formation, the chemical type is changed by cation-exchange softening and sulfate reduction. Therefore, the water from the deeper part of the aquifers is soft, and whereas water from some wells contains large amounts of sulfate, other water contains very little, and the dominant chemical type is sodium bicarbonate. Figure R2-12 shows the relationship between the hardness of water and the depth described by Riffenberg (1925) for the Fort Union and Lance formations. Water from the Fox Hills and Wasatch in the region is similar.

Weathered coal oxidizes on the surface to form the more soluble mineral leonardite with the potential for release of trace elements and water-soluble organic compounds such as phenols. Trace elements, those elements found in the transition series, D block, of the periodic table, generally occur in small amounts in the system relative to other elements. The chemistry of the transition elements is complex in that they have multiple oxidation states and are capable of forming complex compounds with other inorganic or organic constituents.

Many of the transition elements, in minute amounts, are essential to animal and plant nutrition and are therefore incorporated into living things. As coal is more or less a metamorphosed plant material, trace elements are to be expected in coal.

Even though the transition elements accumulate in coal, they are not found in appreciable amounts in water from coal. (See Table R2-7.) Possible controlling mechanisms for the transport of trace elements from the weathered coal to the water are precipitation of insoluble compounds (because of presence of hydrogen sulfide and high pH), and adsorption on the surface of the coal. It is also possible the elements form stable complexes and are not detected by standard analytical methods.

Organic material leaving the leonardite matrix could be transported unchanged, adsorbed on other coaly material, or undergo subsequent reactions such as oxidation or reduction, changing both its physiological and transport properties. Because of the ability of carbon to form chain, branched-chain, cyclic, and ring-like compounds with substituted side chains, the number of organic compounds possible in water is staggering. (See Appendix B, Groundwater, Tables RB-2 and RB-3 for description of classes of organic compounds and results of analysis of water for organics from four wells.)

Alluvium

Yields up to a few hundred gallons per minute can be developed from the alluvium depending on the permeability, saturated thickness, and lateral extent of the alluvium. Recharge is from precipitation, runoff, and, in some areas, water discharged from older formations. Discharge is by evaporation, transpiration, wells, and in some areas, into older formations or flow into streams. The movement of the water for all practical purposes is in the same direction and at the same gradient as the valley in which it is contained, because the alluvium in the valleys is of such limited thickness and width.

The chemical type of the water from the alluvium is similar to that described for water from shallow wells in the Fox Hills, Lance, Fort Union, and Wasatch formations. The water may be higher in dissolved solids, however, as the result of concentration by evaporation and transpiration.

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) defines "alluvial valley floors"for the purposes of the act as "the unconsolidated stream-laid deposits holding streams where water availability is sufficient for subirrigation or flood irrigation agricultural activities but does not include upland areas which are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion, deposits by unconcentrated runoff or slope wash, together with talus, other mass movement accumulation and windblown deposits" The Geological Survey is currently mapping surficial geology in the region and has identified unconsolidated, stream-laid deposits along streams in the region. Results of this work are being published as Miscellaneous Field Studies Maps (MF Map series). The maps may be purchased or may be inspected at some larger public libraries, such as the Natrona County Library. Shallow groundwater occurs in many of the alluvial deposits, and soils and vegetation characteristic of alluvial valleys are present. Therefore, "alluvial valley floors"as defined by SMCRA apparently are present in the region. Hardaway and others (1977) have identified 10.35 square miles of alluvial valley floors within the lease areas of mines that have been approved, or for which approval is pending, in the region.

Surface Water

Streams in the Eastern Powder River Basin of Wyoming are ephemeral (flow in response to rainfall or snowmelt). Most of the stream channels, however, have intermittent reaches that flow for long periods each year at very low rates. This flow is seepage from water stored in the alluvium as the result of precipitation or as the result of the stream intercepting water-bearing rock layers (aquifers). Streams seem to be drier (closer to truly ephemeral) in the south and become progressively wetter in a northern direction.

The region is drained to the east by the Belle Fourche and Cheyenne rivers (about 54% of the region), to the north by the Little Powder River (about 19%), to the west by tributaries of the Powder River (about 16%), and to the south by tributaries of the North Platte River (about 11%). The major stream patterns are dendritic. Mines that have been approved or for which approval is pending will eventually intercept about 1,100 square miles of drainage, mostly in the Belle Fourche River Basin, but the main channels are to be supplemented with by-pass channels so that flow from the drainage will not interrupt mine operations (Figures R2-13 and R2-14).

The mean annual unit streamflow ranges from about 0.008 cubic feet per second per square mile (cfsm) to about 0.011 cfsm from the larger drainages in the region,

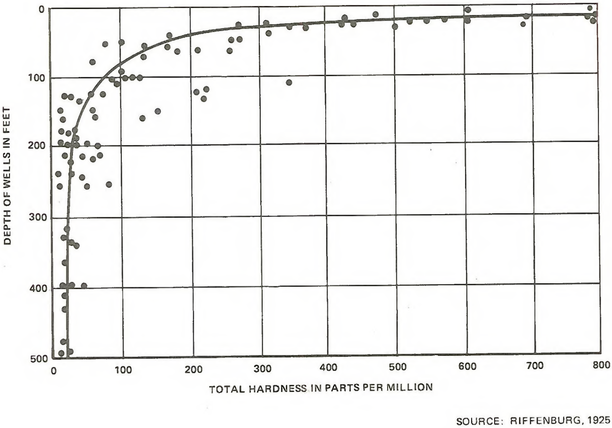


Figure R2-12

RELATION OF TOTAL HARDNESS TO DEPTH OF WELLS IN FORT UNION AND LANCE FORMATIONS

TABLE R2-7

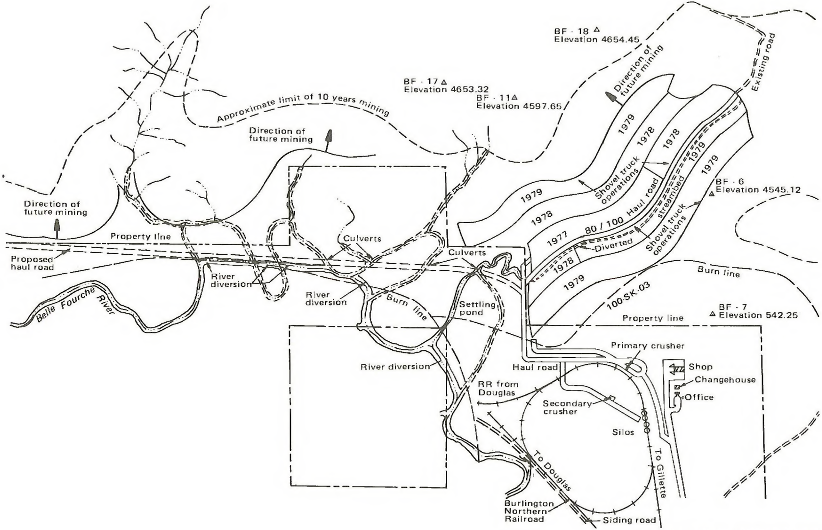
RANGE OF TRACE ELEMENTS AND RADIOCHEMICAL ANALYSIS OF WATER FROM THE FOX HILLS SANDSTONE AND THE LANCE, FORT UNION, AND WASATCH FORMATIONS

Constituent	Range in Concentration*	Constituent	Range in Concentration*
Aluminum	0 - 100	Lead	0 - 10
Antimony	ND**	Lithium	ND - 390
Arsenic	0 - 8	Manganese	ND - 9,100
Barium	0 - 400	Molybdenum	0 - 44
Beryllium	0 - 30	Nickel	0 - 26
Beta emission	ND - 23 pc/l	Nitrate	0 - .49
Bismuth	ND	Nitrite	0 - .01
Boron	0 - 5,400	Radium 226	ND - 2.2
Bromide	0.0 - 3.8	Selenium	0 - 1
Cadmium	0 - 6	Silver	Trace
Chromium	0 - 20	Strontium	ND - 6,500
Cobalt	3< - <50	Tin	ND
Copper	0 - 4	Titanium	ND
Gallium	ND	Vanadium	0 - 31
Germanium	Trace	Zinc	ND - 430
Iodide	0 - .02	Zirconium	ND
Iron	10 - 37,000		

Source: Records of Geological Survey

* Results in micrograms/liter except when otherwise noted

** Analysis has been made, but constituent was not detected



SOURCE: SUN OIL COMPANY, 1974

Figure R2-13
TYPICAL MINE PLAN SHOWING RIVER CHANNEL CUTTOFFS

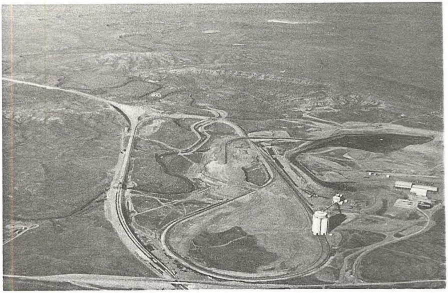


FIGURE R2-14

BELLE FOURCHE RIVER--
CUTOFF CHANNEL SLICES THROUGH BENDS IN THE RIVER
TO DIVERT FLOW PAST MINE

and from about 0.01 cfsm to about 0.05 cfsm from drainages of about 1 square mile. The seasonal distribution of streamflow reflects the seasonal distribution of snowmelt and rainfall. (See Figures R2-15, R2-16, and R2-17.) The hydrographs for the streams in the northern part of the region show two peak runoff periods, one corresponding to the late winter snowmelt, and one corresponding to the spring rainfall. All streams in the region show the characteristic extreme low-flow period from October through January. (See Table RB-5, Appendix B, Surface Water.)

The extreme variation in streamflow from year to year of prairie streams in semiarid areas is illustrated by the maximum and minimum curves in Figure R2-18.

The surface water flow in the region is affected by numerous stock-water reservoirs (mostly limited to a maximum capacity of 20 acre-feet per reservoir as encouraged by state laws (Wyoming State Engineer 1975)) and spreader systems on the small tributaries. Storage and diversion by these structures result in appreciable depletion through evapotranspiration and seepage. A flow rate of about 0.033 cfsm originates on every square mile within the region, but only about 0.014 cfsm runs out of the whole region. This is a depletion of about 58% from the drainages of about one square mile in size to the point at which the streams draining large areas exit the region. Although most streamflow is affected by stock ponds and spreader systems, experience has shown that very high peak flows (flows with a return period of 50 years or more, Table RB-5, Appendix B) are not noticeably reduced. The "flashy"nature of these prairie streams produces very high peaks of short duration. These are due to the high-intensity thunderstorms which supply the southern part of the region with most of the year's precipitation in most years.

The sediment-carrying capacity and erosive power of floods in ephemeral streams is extremely high. Even though the total volume of such floods is much less than that of mountain snowmelt peaks, the peak stages (heights of flood) of the plains streams are often much higher. The highest water-borne sediment concentrations occur during flood periods (see Table RB-6, Appendix B).

Erosion and sedimentation depend upon the energy of the rainfall and water flow, erodibility of the soil, and the protective influence of the vegetative cover. Water-borne sediment originates from sheet erosion and from gully and channel formation. Sheet erosion is caused by raindrop impact and storm runoff which develops rills and small unstable channels. Gullies begin as rills and are generally formed when intense rainstorms provide large volumes of highvelocity flow. L.M. Shown (personal communication 1977) found that sedimentation rates as measured from about 20 ranch ponds scattered through the mine-leased area in Campbell County varied from about 0 to almost 3 acre-feet per square mile per year. Hadley and Schumm (1961) found average rates as measured from about 80 ponds in the Upper Cheyenne River Basin (which covers most of the portion of Converse County in the region) to be 0.13 acre-feet per square mile per year from drainages in the Wasatch Formation, and to be 1.3 acre-feet per square mile per year from drainages in the Fort Union Formation.

Chemical quality of water in a stream continually changes as a result of varying amounts and sources of water. Water in alluvium of the region normally has a higher dissolved solids concentration than storm runoff (high flows dilute low stream flows originating in the alluvium). Salts are deposited by evaporation of low flows (normally from groundwater) in the stream channel.

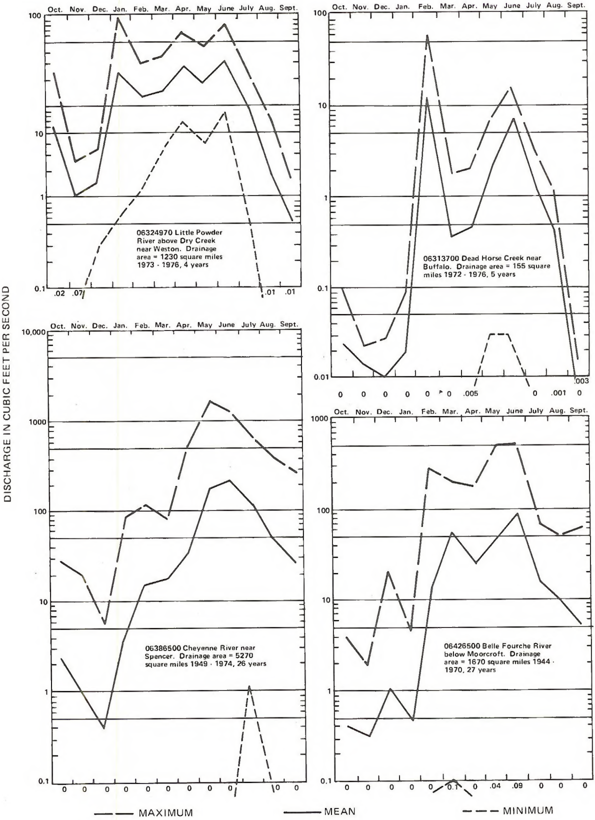
Ranges in some of the major chemical constituents have been listed (Table RB-7, Appendix B) for streams which drain most of the region (Little Powder, Cheyenne, and Belle Fourche rivers) and on one which borders the region on the southwest (Salt Creek). Salt Creek drains the famous oil field at Midwest, Wyoming, and consequently its quality should be affected and the maximums shown in the table should be very high. The period of record of Salt Creek is many years longer than those of the other records listed, and therefore the large differences between maximums and minimums may be the result of this fact.

Ranges in fecal coliform count in colonies per 100 milliliters (followed by the transporting streamflow in cubic feet per second) are given for October 1975 through September 1976 in the annual streamflow data report of the U.S. Geological Survey as follows: 37,600 (1,360) to less than 1 (866 to 1,500) in the North Platte River below Casper and 8,500 (3,790) to 32 (1,650) in the river at Orin; about 2,000 (16) to less than 1 (0.43) in the Little Powder River about 50 miles north of Gillette; about 2,000 (18) to 80 (9.7) in the Cheyenne River (which was dry over half the year) near the state line; and 110 (44) to about 2 (10) in the Belle Fourche River at Devils Tower. The North Platte below Casper was sampled biweekly and the others about monthly. Fecal coliform count is a measure of water pollution by warm-blooded animals.

Water Use

The Wyoming State Engineer (1972) states that of the water presently consumed by man's activities in northeastern Wyoming, over 80% is used for irrigation. The consumption of irrigation water is variable depending upon crop types and climatic factors such as temperature, humidity, and radiation. Because of the limited precipitation in northeast Wyoming, dependable crop production requires irrigation to provide the necessary water. Most irrigation is by direct diversion from streams, and flood irrigation is the principal method of application. Sprinkler irrigation is gaining in popularity, and both surface water and groundwater are used as sources of supply for this type of irrigation.

In the Eastern Powder River Basin, dry farming is the usual practice, although some water-spreader systems are used for supplemental irrigation of hay meadows and pastures. Small amounts of surface water are presently used in coal operations, primarily as process or dust control water. Practically all process water diverted by industry is consumed.



COMPILED FROM U.S.G.S. RECORDS

Figure R2-15

MONTHLY HYDROGRAPHS FOR SELECTED STREAMS

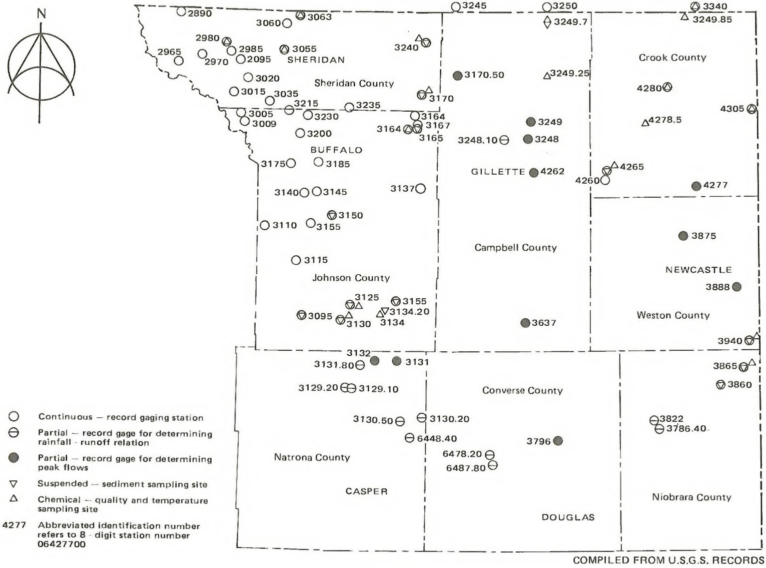


Figure R2-16

LOCATIONS OF SURFACE WATER GAGING STATIONS AND SAMPLING SITES

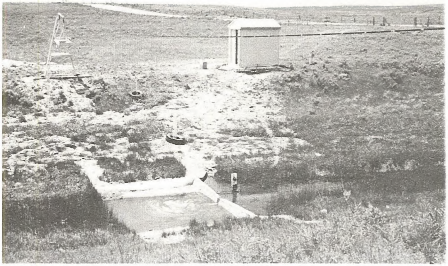
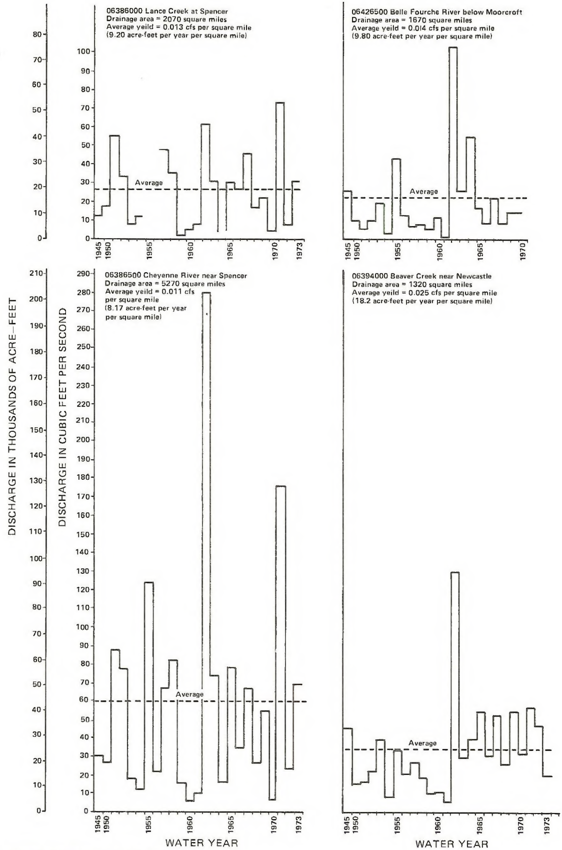


FIGURE R2-17

BELLE FOURCHE RIVER--
STREAM GAGING STATION WITH (1) CABLEWAY FOR MEASURING HIGH FLOWS,
AND (2) SHELTER WHICH HOUSES STAGE-MEASURING, SEDIMENT,
AND WATER QUALITY INSTRUMENTS



COMPILED FROM U.S.G.S. RECORDS

Figure R2-18
YEARLY HYDROGRAPHS OF SELECTED PLAINS STREAMS

Groundwater is considered the primary source of domestic and stock water in the region. Groundwater supplies municipal water for Gillette and Wright, and communities along the North Platte draw their water from the river. Groundwater is used in the secondary recovery of oil, and the petroleum industry is presently the largest industrial user of groundwater. A small amount of groundwater is used for irrigation.

The total water consumption in the region by agriculture, industry, municipal, and domestic use is estimated from data in a report of the Wyoming State Engineer (1972) as about 45,000 acre-feet per year. Detailed studies of present water use and potential developments have been made by the Wyoming State Engineer (1971, 1972, 1973, 1974).

VEGETATION

The Eastern Powder River Basin of Wyoming is considered an ecological transition zone between the true shortgrass plains to the east and the northern desert shrub type to the west. Local vegetation communities may be dominated in appearance by big sagebrush, they also contain numerous grass and forb species common to the shortgrass communities of the Great Plains. While both coniferous and deciduous woodland occur locally, the vegetation typically consists of low-growing shrubs, herbaceous plants, and grasses adapted to the semiarid condition of the region.

Vegetation in the region is influenced by a large number of factors. Among the most important determining and controlling factors are grazing, fire, climate (especially precipitation), soil, and topography. Soil is especially important for site-specific plant species. Fire has played an important role in controlling sagebrush. The advent of fire control has allowed sagebrush to dominate vegetation in large portions of the region.

No attempt will be made to describe the great variety of vegetation types and subtypes that occurs, but the more representative communities are briefly described below and are shown on Map 5, Appendix A.

Terrestrial Vegetation

Playa Grassland (map symbol 1A) (250 acres)

Scattered through the level to gently-sloping upland regions of southern Campbell and northern Converse counties are numerous playas (dry lakes) of varying size. These playas (Figure R2-19) are seasonally inundated with runoff water from adjacent uplands and have deep, poorly drained, very clayey soils. A very distinctive grassland type with western wheatgrass *(Agropyron smithii)* as the dominant species occurs on the playa sites. Subordinate species appear to be dependent on length and degree of inundation. On playas where surface water evaporates rather rapidly and the subsurface water table drops, foxtail barley *(Hordeum jubatum)* is the second most important grass and almost the only other plant species present. On wetter playas, slender spike rush *(Eleocharis aricu*laris) is codominant with western wheatgrass.

Scoria Grassland (map symbol 1B) (27,300 acres)

A distinctive grassland type is found on scoria (clinker) hills and ridges that are a prominent landscape feature in Campbell and northern Converse counties. The scoria areas have relatively rough, steep topography, and sandy to gravelly loam soils with low water-holding capacity. Bluebunch wheatgrass *(Agropyron spicatum)* is the most characteristic species, although blue grama *(Bouteloua gracilis)* is often the most productive grass. Other grasses and shrubs found in this plant community are as follows: little bluestem *(Andropogon scoparius)*, prairie sandreed *(Calamovilfa longifolia)*, sand dropseed *(Sporoblus cryptandrus)*, Indian ricegrass *(Orysopsis hymenoides)*, needle-and-thread *(Stipa comata)*, prairie junegrass *(Koeleria cristata)*, globemallow *(Sphaeralcea* spp.), lupine *(Lupinus* spp.), small soapweed *(Yucca glauca)*, big sagebrush *(Artemisia tridentata)*, and skunkbush sumac *(Rhus trilobata)*.

Other shrubs and stunted Rocky Mountain juniper *(Juniperus scopulorum)* may be present in draws where moisture conditions are somewhat better.

Sandhills Grassland (map symbol 1C) (90,100 acres)

In southwestern Converse County, just north of the North Platte River, is a region of sand dunes. Both active and stablized dunes are present. The vegetation on these dunes is open grassland with prairie sandreed the most conspicuous grass. Needle-and-thread, Indian ricegrass, blue and hairy grama, sand dropseed, and Sandberg bluegrass *(Poa secunda)* are common. Scattered sand bluestem *(Andropogon hallii)* may be present. Silver sagebrush *(Artemisia cana)* may occur, and in some areas rather dense stands have developed. Small soapweed, fringed sage *(A. frigida)*, and cudweed sagewort *(A. graphaloides)* may be locally abundant.

Sagebrush-Grass (map symbol 4) (4,188,150 acres)

The shrub layer of the sagebrush-grass community (Figure R2-20) is composed almost exclusively of big sagebrush. The density (plants/unit area) of the big sagebrush layer varies from a few scattered plants, with a predominantly grass understory, to closely spaced or clumped shrub stands with little or no herbaceous understory. In the latter instance, crowns of individual plants normally do not touch. The height of the shrub layer rarely exceeds 18 to 24 inches.

The major understory species is blue grama, which is found almost everywhere. Taller grasses such as needle-and-thread and western wheatgrass are also abundant. These latter two species vary in abundance from year to year, and it is thought this variation is, to some extent, controlled by variations in moisture. Needle-and-thread

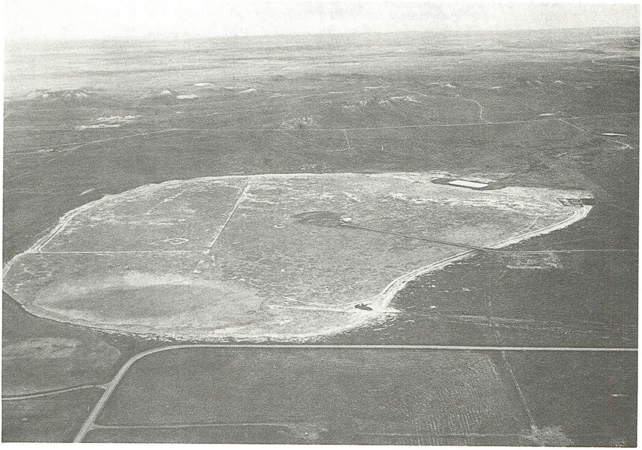


FIGURE R2-19

PLAYA

FIGURE R2-20

SAGEBRUSH-GRASS VEGETATION

seems better adapted to soils which tend to be sandy and may dry out rapidly, while western wheatgrass is better adapted to clayey soils which hold available water into the growing season.

Secondary plants include: Sandberg bluegrass, prairie junegrass, threadleaf sedge *(Carex filifolia)*, Indian ricegrass, green needlegrass *(Stipa viriduala)*, bluebunch wheatgrass, cheatgrass *(Bromus tectorum)*, and plains pricklypear *(Opuntia polycantha)*.

The big sagebrush-grass vegetation type is by far the most widespread shrub community in the region. Other shrub communities do occur, but occupy rather specific habitats. Big sagebrush may be present in some of these other shrub communities, but other species are more characteristic.

Silver Sagebrush (map symbol 4A) (36,900 acres)

The silver sagebrush shrub community is widespread throughout the region, occurring under many conditions. It is most common on level to gently sloping floodplains of streams which run water during at least part of the growing season, or on land which receives additional water from overflow. Soils of these sites are deep, well drained and permeable, somewhat sandy or loamy, and usually not extremely saline or alkaline. Silver sagebrush may form rather dense stands and grows 2 to 3 feet tall. The predominant understory grass is western wheatgrass. Needle-and-thread, Sandberg bluegrass, mat muhly *(Muhlenbergia squarrosa)*, blue grama, prairie junegrass, and threadleaf sedge are present to a lesser extent, especially on areas subject to moderate to heavy grazing pressure. On lightly grazed areas, wildrye *(Elymus* spp.), green needlegrass, and several species of bluegrass are present. Forbs are scarce. Occasionally, snowberry *(Symphoricarpos* spp.) shrubs are present.

Greasewood-saltbush (map symbol 5) (82,960 acres)

Another shrub community is present along stream channels, on flood-plains which receive additional water from overflow or runoff, and in areas where soils are moderately to strongly saline or alkaline. The shrub layer of this plant community is characterized by a moderate to heavy stand of black greasewood *(Sarcobatus vermiculatus)* with some scattered rubber rabbitbrush *(Chrysothamnus nauseousus)*. Other shrub species include: fourwing saltbush *(Atriplex canescens)*, Gardner saltbush *(Atriplex gardneri)*, and winterfat *(Eurotia lanata)*. Grasses include: inland saltgrass *(Distichlis stricta)* squirreltail *(Sitanion hystrix)* alkali bluegrass *(Poa juncifolia)* alkali sacaton *(Sporobolus airoides)*.

The three shrub communities (sagebrush, silver sagebrush, and greasewood-saltbush) form a vegetative mosaic with the grassland communities. Where the density of shrubs is low, the community may have the appearance of grassland; however, it is not known whether these areas are "true grasslands,"places where the growth of shrubs, particularly big sagebrush, is limited by specific factors. The only communities in the region where grasses and sedges are known to dominate are characterized by either high soil moisture, or shallow, stony soil, or sand dunes.

Ponderosa Pine Forest (map symbol 6) (328,400 acres)

Areas where trees are dominant are present in the region. The most widely distributed type is ponderosa pine *(Pinus ponderosa)* forest (Figure R2-27). This vegetation type is well distributed over the badlands-scoria region north and east of Gillette in Campbell County. It extends southward in a long, narrow band to the vicinity of Lusk where it swings west toward Douglas. A distinct area of ponderosa pine is present on the western edge of Converse County, east of Midwest. The distribution of ponderosa pine forest appears to be limited to the crests of sandstone, shale, and scoria outcrops.

Ponderosa pine is the principal tree species. It grows in stands which range from closed-canopy forests to savannahlike woodlands. The shrub species in the understory of the denser forest stands include skunkbush sumac, creeping juniper *(Juniperus horizentalis)*, and western snowberry *(Symphoricarpos occidentalis)*. The herbaceous layer is composed mostly of grasses. Major species are green needlegrass, Sandberg bluegrass, prairie junegrass, and stony hills muhly. In open stands of ponderosa pine, silver sagebrush, green needlegrass, and sideoats grama *(Bouteloua curtipendula)* are the major understory species. On sites with coarser soils, bluebunch wheatgrass, little bluestem, and porcupine needlegrass *(Stipa spartea)* may be present.

Riparian Vegetation (map symbol 10) (224,500 acres)

This vegetation type occurs along drainages and adjacent to lakes, ponds, and springs where moisture accumulates in the soil (Figure R2-26). Some portions are periodically inundated, while other portions are much drier. Included in this type are groves of deciduous trees, meadows, marshlands, and open grasslands. This vegetative type occurs in alluvial valley floors in the region.

Broadleaf trees are present on some of the perennial stream floodplains (Cheyenne, Belle Fourche, Powder, and Little Powder rivers) and intermittent streams which flow eastward and northward from Campbell and northern Converse counties. The density of the trees ranges from scatterings of single trees, to fringing rows, to riparian woodlands extending several miles along the stream channel and 2 to 3 miles on either side of it. The latter type of forest is most prevalent on the eastern edge of the two counties. Plains cottonwood *(Populus sargentii)* is the characteristic tree for this vegetation type, although lanceleaf cottonwood *(P. acuminata)* may also be present. Other less common trees are sandbar willow *(Salix interior)*, coyote willow *(S. exigua)*, peachleaf willow *(S. amygdaloides)*, and boxelder *(Acer negundo)*.

Important grasses and forbs are: prairie cordgrass *(Spartina pectinata)*, tufted hairgrass *(Deschampsia caespi-*

tosa), slender wheatgrass *(Agropyron trachycaulum)*, western wheatgrass, inland sedge *(Carex interior)*, baltic rush *(Juncus balticus)*, arrowgrass *(Triglochin* spp.), and golden pea *(Thermopsis* spp.).

Soils on many of these riparian sites have high organic matter content. Some of the meadows are very productive and are mowed for wild hay or used for other agricultural purposes.

Aquatic Vegetation

Aquatic type refers to the vegetation associated with permanent pools along drainages, reservoirs, and ponds. Aquatic vegetation is limited to species which require wet ground but which can exist for long periods without standing water. Species include bulrush *(Scirpus* spp.), common cattail *(Typha latifolia)*, sedges, watercrowfoot *(Ranunculus aquatilis)*, and filamentous green algae. This vegetative type occurs in alluvial valley floors. This type is not delineated separately, but is included in the riparian type on the vegetation map.

Endangered and/or Threatened Species

No plants listed as endangered or threatened species have been identified in the region (Keenlyne 1977, *Federal Register* 1976).

A plant *(Aquilegia laramiensis)* found in the mountainous areas of southern Converse County is a candidate for the endangered or threatened list. It is not likely to be found in the semiarid environment of the Eastern Powder River Basin.

Each site proposed for mining or other development must be examined to determine whether threatened or endangered plants exist.

FISH AND WILDLIFE

The region to be analyzed is in northeastern Wyoming and includes all of Campbell County and that portion of Converse County north of the North Platte River. The area includes 4,978,560 acres composed primarily of rolling plains, low mountains, rough breaks, and rocky ridges.

Vegetation in the region is diverse and ranges from pure grassland, to the dominant sagebrush-grassland type, to wooded drainages and timbered hills.

Habitat Types

Aquatic

The aquatic habitat consists primarily of 47 scattered livestock reservoirs, covering 406.1 acres, and 224.3 miles of streams, which support fish populations.

Most of the streams in this region are ephemeral or intermittent. The only perennial streams are the middle and lower sections of the Powder, Little Powder, and Belle Fourche rivers. Most of the tributary streams to these rivers do not support any fish because of a lack of sustained flow.

The perennial streams in the region are shallow, slow-moving, and turbid. Flows vary greatly due to precipitation and runoff fluctuations. Water temperature also fluctuates widely with changes in stream flow. These conditions tend to favor a variety of warm-water species.

The largest fishery in the vicinity of present and projected coal mining activity is Keyhole Reservoir on the Belle Fourche River. The reservoir lies outside the boundaries used in this regional analysis, but is considered because much of the coal mining in the Eastern Powder River Basin takes place in the Belle Fourche watershed.

Table R2-8 presents the species of fish found in the region by occurrence in the major drainages.

Terrestrial

The location and relative size of each habitat type listed in Tables R2-9 through R2-16 is illustrated on the regional vegetation map (Map 5, Appendix A).

Fish

Introduction

There are an estimated 224.3 miles of stream in the region which support some type of fish, primarily nongame. These include parts of 117 miles of the Little Powder River, an 11-mile section of the Powder River, 96.3 miles of the Belle Fourche River, 18 miles of Caballo Creek, and 20 miles of Little Thunder Creek (personal communication, John Mueller, Wyoming Game and Fish 1978). The locations of the streams mentioned are shown on Map 1, Appendix A.

Nongame

The nongame fish species occurring most frequently in the region are listed in Table R2-8. Most nongame fish in the region are members of the minnow family.

Game

Many of the livestock reservoirs and some streams contain stocked or native populations of trout, bass, black bullhead, and/or green sunfish (see Table R2-8).

No game fish are known to occur in the Cheyenne River drainage in this region. The largest fishery in the vicinity of the coal mines is Keyhole Reservoir, on the Belle Fourche River.

TABLE R2-8

CHECKLIST OF THE FISHES IN THE EASTERN POWDER RIVER REGION

Species	Little Powder River drainage	Powder River drainage	Belle Fourche River drainage	Cheyenne River drainage
Sensitive*				
Shovelnose sturgeon (*Scaphirhynchus platorynchus*)		S		
Goldeye (*Hiodon alosoides*)	S	S		
Sturgeon chub (*Hybopsis gelida*)		S		
Silvery minnow (*Hybognathus nuchalis*)		S		
Non-game				
Carp (*Cyprinus carpio*)	S	S	S, P	S
Flathead chub (*Hybopsis gracilis*)	S	S	S	S
Longnose dace (*Rhinichthys cataractae*)	S	S	S	S
Creek chub (*Semotalus atromaculatus*)		S	S	
Sand shiner (*Notropis stramineus*)	S	S	S	S
Flathead minnow (*Pimephales promelas*)	S	S	S	S
Plains minnow (*Hybognathus placitus*)	S	S	S	S
Goldfish (*Carassius auratus*)		S	S	
Brassy minnow (*Hybognathus hankinsoni*)		S		
River carpsucker (*Carpoides carpio*)	S	S		
Northern redhorse (*Moxostoma macrolepidotum*)	S	S	S	
Common white sucker (*Catostomus commersoni*)	S	S	S	S
Mountain sucker (*Catostomus platyrhynchus*)	S	S		
Plains killifish (*Fundulus kansae*)				S
Game				
Black bullhead (*Ictalurus melas*)	S, P		S, P	P
Stonecat (*Notorus flavus*)	S	S		
Channel catfish (*Ictalurus punctatus*)	S	S		
Green sunfish (*Lepomis cyanellus*)	S, P		S, P	P
Bluegill (*Lepomis macrochirus*)				P
Largemouth bass (*Micropterus salmoides*)	P		P	P
Yellow perch (*Perca flavescens*)			S	
Walleye (*Stizostedion vitreum*)			S, P	
Rainbow trout (*Salmo gairdneri*)			S, P	
Brown trout (*Salmo trutta*)			S	
Brook trout (*Salvelinus fontinalis*)	S		S, P	

Source: Data from Wyoming Game and Fish Department 1978 as part of contract Number YA-512-CT8-126.

Note: S = Fish found in streams; P = Fish found in ponds or reservoirs.

* Considered rare in Wyoming (Wyoming Game and Fish 1977).

TABLE R2-9

SAGEBRUSH - GRASS
(4,188,150 acres)

BIRDS

Non-game	Game
Horned lark	Sage grouse
Lark bunting	Mourning dove
Western meadowlark	Sharp-tailed grouse
Brewer's sparrow	
Sage sparrow	
Vesper sparrow	
Chestnut-collared longspur	
Sage thrasher	

MAMMALS

Non-game	Furbearers/Predators	Game
Deer mouse	Badger	Desert cottontail
Thirteen-lined ground squirrel	Bobcat	Mule deer
Grasshopper mouse	Coyote	Pronghorn
Least chipmunk	Red fox	
Sagebrush vole		
White-tailed jackrabbit		

REPTILES/AMPHIBIANS

Northern sagebrush lizard
Eastern short-horned lizard
Prairie rattlesnake
Bullsnake
Plains spadefoot toad
Great Plains toad

Note: There are several species which require this habitat type for one or more of their vital life functions. The sage sparrow, Brewer's sparrow, mourning dove, and sage grouse all require sagebrush to nest in, or as nesting cover. Big sagebrush is the major component of the diets of sage grouse and pronghorn. It is also an important part of the winter diet of mule deer. Sagebrush provides escape and protective cover for many small mammals such as jackrabbits, cottontails, least chipmunks, and deer mice.

TABLE R2-10

PONDEROSA PINE
(328,400 acres)

BIRDS

Non-game	Game
Blue jay	Mourning dove
Black-capped chickadee	Wild turkey
Brown creeper	
Red-breasted nuthatch	
Common flicker	

MAMMALS

Non-game	Furbearers/Predators	Game
Bushy-tailed woodrat	Red fox	Snowshoe hare
Deer mouse	Bobcat	Mule deer
Least chipmunk		Elk
Vagrant shrew		

REPTILES

Eastern short-horned lizard
Prairie rattlesnake
Western smooth green snake
Bullsnake

Note: This special habitat type supports several animals. Wild turkeys require trees for roosting and escape. They also use this habitat for nesting, especially where numerous downed limbs are available for cover. Snags are necessary for cavity-nesting birds such as the black-capped chickadee, red-breasted nuthatch, common flicker, kestrel, and great horned owl. Species such as nuthatches, wood-peckers, and chickadees forage in the bark or foliage of the pines for insects. Mule deer use the trees for protective cover.

TABLE R2-11

RIPARIAN
(224,500 acres)

BIRDS

Non-game	Game
Western kingbird	Sharp-tailed grouse
American goldfinch	Mourning dove
Yellow warbler	Wild turkey
Robin	Coot
Yellow-breasted chat	Mallard
Willet	American widgeon
American avocet	Pintail
Spotted sandpiper	Blue-winged teal
Lesser yellow legs	Green-winged teal
Eared grebe	Canvasback
Killdeer	Canada goose

MAMMALS

Non-game	Furbearers/Predators	Game
Vagrant shrew	Beaver	Snowshoe hare
Wandering shrew	Muskrat	Mule deer
Deer mouse	Mink	White-tailed deer
Northern pocket gopher	Raccoon	
Montane vole	Striped skunk	
	Bobcat	
	Red fox	

REPTILES/AMPHIBIANS

Tiger salamander
Boreal chorus frog
Leopard frog
Plains spadefoot toad
Prairie rattlesnake
Plains hognose snake
Western plains garter snake
Wandering garter snake
Snapping turtle
Western spiny soft-shelled turtle
Western painted turtle

Note: This vegetative type is the most important type in the region in terms of wildlife diversity. The presence of this habitat type adjacent to large areas of uniform vegetation greatly increases the types and amounts of food and cover available to wildlife. The availability of water in this habitat increases the overall value to wildlife.

TABLE R2-11
(cont'd)

RIPARIAN
(224,500 acres)

The robin, western kingbird, goldfinch, yellow warbler, and numerous other passerine species nest in the dense woody cover. Snags, especially dead cottonwoods, are necessary for cavity nesters such as screech owls, and mountain bluebirds. Many waterfowl nest in riparian areas, especially in areas adjacent to large stock ponds. Herbaceous species, such as cattail and bulrush, are favored nesting materials and provide cover in the denser stands.

Mink prefer hunting in the riparian areas and make extensive use of these areas year round. Muskrat and beaver are obligate residents of this habitat. Beaver use the woody vegetation, especially willows, for food and for constructing lodges and dams in areas where they do not burrow into streambanks for shelter. Muskrats use the aquatic herbaceous vegetation for food and for constructing their shelters. The distribution of white-tailed deer in this region closely corresponds with the distribution of riparian cover along perennial and intermittent streams in the region.

Use of riparian habitat by amphibians and aquatic reptiles is directly related to the availability of water.

TABLE R2-12

SANDHILLS GRASSLAND
(90,100 acres)

BIRDS

Non-game	Game
Horned lark	Mourning dove
Vesper sparrow	Hungarian partridge
Lark bunting	
Savannah sparrow	
Western meadowlark	
Chestnut-collared longspur	

MAMMALS

Non-game	Furbearers/Predators	Game
Deer mouse	Badger	Pronghorn
Thirteen-lined ground squirrel	Coyote	
Grasshopper mouse	Bobcat	
Ord's kangaroo rat		
Hispid pocket mouse		
Northern pocket gopher		

REPTILES/AMPHIBIANS

Prairie rattlesnake
Eastern short-horned lizard
Plains hognose snake
Bullsnake
Western plains garter snake

Note: Animals listed for this and the other grassland habitats are also found in the adjacent brush types. Due to lack of heavy cover, birds which nest in the grasslands build ground nests which often are nothing more than small depressions in the sand, Small rodents use burrows for escape and protective cover. The larger mammals, such as coyotes and pronghorn, are mobile enough to use a variety of habitats for food and cover and are not required to use special measures to provide their own cover.

TABLE R2-13

GREASEWOOD - SALTBUSH
(82,960 acres)

BIRDS

Non-game	Game
Loggerhead shrike	Mourning dove
Yellow warbler	
Lark bunting	
Western meadowlark	
Robin	
Red-winged blackbird	

MAMMALS

Non-game	Furbearers/Predators	Game
Deer mouse	Badger	Desert cottontail
Grasshopper mouse	Coyote	Mule deer
Least chipmunk	Bobcat	
	Red fox	
	Striped skunk	

REPTILES/AMPHIBIANS

Eastern short-horned lizard
Prairie rattlesnake
Western smooth green snake
Bullsnake

Note: The most important value of this habitat to wildlife is the presence of brush for cover. Animals listed in this section and the silver sagebrush section are found in the other brush types in the region.

TABLE R2-14

SILVER SAGEBRUSH
(36,800 acres)

BIRDS

Non-game		Game
Horned lark		Sage grouse
Lark bunting		Mourning dove
Western meadowlark		
Brewer's sparrow		
Vesper sparrow		

MAMMALS

Non-game	Furbearers/Predators	Game
Deer mouse	Badger	Desert cottontail
Thirteen-lined ground squirrel	Coyote	Pronghorn
Grasshopper mouse	Bobcat	Mule deer
Least chipmunk	Long-tailed weasel	

REPTILES/AMPHIBIANS

Northern sagebrush lizard
Eastern short-horned lizard
Prairie rattlesnake
Plains hognose snake
Bullsnake

Note: For the purpose of analysis, this vegetative type has been combined with the sagebrush-grass type in subsequent chapters.

TABLE R2-15

SCORIA GRASSLAND
(27,300 acres)

BIRDS

Non-game	Game
Horned lark	Hungarian partridge
Grasshopper sparrow	
Savannah sparrow	
Lark bunting	

MAMMALS

Non-game	Furbearers/Predators	Game
Deer mouse	Badger	Desert cottontail
Thirteen-lined ground squirrel	Coyote	Pronghorn
Grasshopper mouse	Bobcat	
Ord's kangaroo rat	Red fox	
Western harvest mouse		

REPTILE/AMPHIBIANS

Prairie rattlesnake
Eastern short-horned lizard
Plains hognose snake
Bullsnake
Western plains garter snake

TABLE R2-16

PLAYA GRASSLAND
(250 acres)

BIRDS

Non-game	Game
Savannah sparrow	Hungarian partridge
Grasshopper sparrow	
Western meadowlark	
Horned lark	

MAMMALS

Non-game	Furbearers/Predators	Game
Deer mouse	Badger	Pronghorn
Northern pocket gopher	Striped skunk	
Hispid pocket mouse		
Western harvest mouse		

REPTILES/AMPHIBIANS

Prairie rattlesnake
Eastern short-horned lizard

Sensitive Species

There are four species of fish which the Wyoming Game and Fish Department lists as rare (1977), and which may occur in the region: the shovelnose sturgeon, the sturgeon chub, the goldeye, and the silvery minnow. All of these species may be found in the Powder River or Little Powder River.

Endangered and/or Threatened Species

No endangered or threatened fish species are known to occur in the Eastern Powder River Basin.

Wildlife

Birds

A complete list of birds occurring in the region is in Appendix B.

Nongame. Most songbirds in this region are migratory. They arrive in late spring to nest and raise their young and leave by late September. Densities of birds therefore vary greatly by season. Table R2-17 presents density figures by habitat type.

Raptors. The rolling plains of the region provide excellent hunting habitat for raptors. Raptor numbers in the region are restricted due mainly to the scarcity of preferred nesting areas, which are located primarily along wooded drainages and rock cliffs or escarpments.

Raptor species known to occur in the region are goshawk, sharp-shinned hawk, Cooper's hawk, marsh hawk, red-tailed hawk, Harlan's hawk, Swainson's hawk, ferruginous hawk, rough-legged hawk, golden eagle, bald eagle, prairie falcon, peregrine falcon, merlin, kestrel, great horned owl, screech owl, burrowing owl, barred owl, long-eared owl, short-eared owl, saw-whet owl, and turkey vulture.

Hawks, other than the rough-legged hawk, migrate from the region in the fall and return in early spring.

Density figures for raptors are shown in Table R2-17.

Game. Sage grouse is the most important game bird species in the region. Sage grouse have been observed on four of the existing mine leases; one of the sites has sage grouse strutting grounds within the lease boundaries. Doves are the most abundant game bird species in the region. Other game birds are found in scattered populations or require specialized habitat. Included in this category are sharp-tailed grouse, wild turkey, Hungarian partridge, ring-necked pheasant, American coot, and waterfowl. Density estimates are shown in Table R2-17.

Sensitive Species. The Wyoming Game and Fish Department lists only the burrowing owl as rare in the region (1977).

Endangered and/or Threatened Species. Three endangered bird species which may occur in the Eastern Powder River Basin are the bald eagle, the peregrine falcon, and whooping crane. The latter two are possible migrants (personal communication, Harry Harju, Wyoming Game and Fish Department 1978).

Bald eagles winter along Antelope Creek, Porcupine Creek, the North Platte River near the Dave Johnston Power Plant, and the forks of the Cheyenne River.

Mammals

A complete list of mammals occurring in the region appears in Appendix B.

Nongame. The most common nongame mammals found in the region are noted in the habitat tables at the beginning of this section. Density figures for each habitat type appear in Table R2-18.

Furbearers. Beaver, muskrat, mink, and badger are the only state-listed furbearers in the region. Beaver, muskrat, and mink live in riparian areas, whereas the badger lives in a number of upland sites.

Game. The Wyoming Game and Fish Department estimates that there are 48,000 pronghorn antelope in the Eastern Powder River Basin (personal communication, Roger Wilson and Bill Helms, Wyoming Game and Fish Department 1977). The Wyoming Game and Fish Department projects a decrease in total numbers by 7.9% to 44,200 animals by 1983 (1978a). This is nearly 20% of the total antelope population in the state of Wyoming. (See Map 6, Appendix A.)

Pronghorn and other big game animals in the state are managed by herd units. There are parts of several herd units in the region. The major units are the Powder River, North Black Hills, Pumpkin Buttes, Bear Creek, Lance Creek, and Sage Creek. The boundaries of these units generally correspond to major roads, which are usually fenced with woven wire and are antelope-proof. Densities for the major herd units are shown in Table R2-18.

The total mule deer population in the region is estimated by the Wyoming Game and Fish Department of be 30,000 (ibid.). The mule deer population is projected to decrease by 3.1% to 29,070 by 1983 (ibid.).

Data on major mule deer herd units, and density in each herd unit are shown in Table R2-18.

A small herd of elk lives in the Fortification Creek area of western Campbell County and eastern Johnson County. Although this area would not be directly impacted by surface coal mining, the increased human population in the region may directly affect this area. Currently there are approximately 200 elk in this herd unit.

White-tailed deer occur in the region along the major drainages. Their range closely corresponds to the riparian vegetation along these streams. Density figures for the Powder River and Thunder Basin herd units are shown in Table R2-18.

Endangered and/or Threatened Species. The only mammalian species considered endangered that may exist in the region is the black-footed ferret. Recent sightings within the region have been documented (Clark 1977), and those sightings classified as positive by Clark are as follows: a sighting by J. Heasley on July 29, 1974, 10 miles west of Reno Junction in T. 43 N., R. 73 W., Section 5, in Campbell County; and a sighting by J. Tate on May 15, 1976, in T. 43 N., R. 70 W., Section 30, in Campbell County. The black-footed ferret is closely as-

TABLE R2-17

A SUMMARY OF AVERAGE BIRD DENSITIES/ACRE BY HABITAT TYPE

BIRDS	Grassland	Sagebrush	Conifer (Ponderosa Pine)	Riparian	Greasewood	Crop Lands	Wetlands
	HABITAT TYPE						
Nongame*	1.36-8.00	2.44-5.1	5.36-12.87	10.37-21.63	1.3	1.3-1.7	
Raptors**	.005		.005	.005	.005		
Game							
Waterfowl***							26.5
Turkey			.03				
Sharp-Tailed Grouse		.01-.06					
Sage Grouse		.05-.08					
Gray Partridge	.02-0.1			0.2		.02-.1	
Morning Dove		0.1****	.01-1.2	.04-0.7			

Note: Density data from Wyoming Game and Fish Department 1978, Contract No. YA-512 CT8-126.

* All nongame birds except raptors.
** All hawks, owls, eagles, falcons, and vultures.
*** All ducks, geese, rails, coots, and grebes.
**** Data from Wyoming Game and Fish Department site-specific investigations and coal company wildlife surveys.

TABLE R2-18

A SUMMARY OF AVERAGE MAMMAL DENSITIES/ACRE BY HABITAT TYPE

	HABITAT TYPE					
MAMMALS	Grasslands	Sagebrush	Conifers (Ponderosa Pine)	Riparian[1]	Greasewood	Wetlands
Nongame[2]	7.4-24.4	9.32-52.72	18-32.3	24.9-71.2	6	
Furbearers[3]						
Beaver				0.2		
Muskrat						8.4
Mink				.03-0.1		
Coyote[4]		0.3			0.3	
Bobcat[4]		7.0				
Badger[5]						
Small Game						
Desert Cottontail	.04	0.2			1.4-4.4	
Snowshoe Hare			0.4	0.4		
Big Game[6]						
Antelope[4]						
Powder River H.U.		3.0				
Pumpkin Butte H.U.		6.0				
Bear Creek H.U.		5.8				
Lance Creek H.U.		5.1				
North Black Hills H.U.		4.1				
Mule Deer[4]						
Pumpkin Butte H.U.		2.0				
Lance Creek H.U.		2.2				
Ormsby H.U.		2.0				
Powder River H.U.		6.5				
Thunder Basin H.U.		3.0				
West Bill H.U.		2.0				
White-Tailed Deer[4]						
Thunder Basin H.U.		0.4				
Powder River H.U.		1.7				

TABLE R2-18
(cont'd)

A SUMMARY OF AVERAGE MAMMAL DENSITIES/ACRE BY HABITAT TYPE

MAMMALS	Grasslands	Sagebrush	Conifers (Ponderosa Pine)	Riparian[1]	Greasewood	Wetlands
	HABITAT TYPE					
Elk[4]						
Fortification H.U.		0.4				

Note: Density data from Wyoming Game and Fish Department 1978, Contract No. YA-512 CT8-126.
H.U. = Herd Unit.

[1] Includes figures for meadow habitat.

[2] All nongame mammals including state-listed predators.

[3] Furbearers and furbearing predators.

[4] Density/square mile.

[5] No data available.

[6] All habitat types.

sociated with prairie dog towns (see Map 7, Appendix A), which are considered primary ferret habitat.

Reptiles and Amphibians

General. The following reptile species may be found in the region: prairie rattlesnake, bull snake, milk snake, plains garter snake, yellow-bellied racer, plains hognose snake, western smooth green snake, wandering garter snake, common garter snake, horned lizard, sagebrush lizard, snapping turtle, painted turtle, and the western spiny soft-shelled turtle. Amphibians which may occur in the region are the spadefoot toad, Great Plains toad, Rocky Mountain toad, boreal chorus frog, leopard frog, and the tiger salamander.

Table R2-19 presents densities by habitat type for each reptile and amphibian species found in the region. The density figures presented do not account for the animals' often patchy distribution. Many suitable areas may be unoccupied. No data were available for some species, so data for similar species and habitats were extrapolated.

Sensitive Species. The milk snake and the western smooth green snake are listed as rare by the Wyoming Game and Fish Department (1977).

Endangered and/or Threatened Species. No endangered or threatened reptile or amphibian species are known to occur in the Eastern Powder River Basin.

CULTURAL RESOURCES

Cultural resources constitute integral and nonrenewable portions of the human environment—fragile and limited evidence of past human activity, which is reflected in sites, structures, artifacts, objects, ruins, works of art, or documentation. Cultural resources represent a continuum of events which are discussed in terms of prehistoric, ethnohistoric, and historic values. For purposes of this document, prehistoric cultural resources represent Indian utilization of a region prior to the influences of European contact. The Indian utilization of a region after the influence of European contact is the ethnohistoric period, and historic resources are those representing European/American exploration and settlement.

This discussion is limited, where possible, to the Eastern Powder River Basin of Wyoming. It should be noted that the cultural resources of an area are only slightly influenced by political boundaries, and in this case political boundaries have been present only during the most recent historic period. Actual consideration of cultural resources must be conducted along the geographic or ecological boundaries which have influenced cultural development.

Cultural resource inventories in the region have been scattered and sporadic until recently. Many of the recent cultural resource inventories have been undertaken to comply with Section 106 of the Historic Preservation Act of 1966 and Section 2(b) of Executive Order 11593, "Protection and Enhancement of the Cultural Environment"

Prehistoric

Before 1973, only two systematic professional archeological studies had been conducted in the region. The River Basin Survey conducted the first of these in 1949 for the proposed Moorehead Reservoir (Wheeler 1949). Even though several sites of value were identified, no investigations of consequence resulted. The second was the excavation of the Ruby site in 1971 (Frison 1971). Since 1973, many archeological investigations have been conducted for various coal and uranium mines, oil well locations, transmission lines, and roads to comply with Section 106 of the Historic Preservation Act and with Executive Order 11593. Even though minor excavations have been conducted on identified sites, only preliminary reports are available; however, further work is in progress. The Wyoming State Archeologist has completed a report on the "Archeology of the Eastern Powder River Basin, Wyoming"compiling available data which provides supporting documentation for this section (Zeimens and Walker 1977).

The prehistoric chronology developed for this region is based on excavations within larger geographic and ecological boundaries. To date, there have not been sufficient studies conducted to fully develop a chronology without depending upon studies conducted outside the region. The first chronological sequence for the northwest plains was developed by Mulloy (1958), and studies conducted since have led to a revision of the chronology by Frison (1978). The chronology which Frison has presented is defined in terms of five broad periods: Paleo-Indian, 11,200 to 7,500 years ago; Early Plains Archaic, 7,500 to 5,000 years ago; Middle Plains Archaic, 5,000 to 3,000 years ago; Late Plains Archaic, 3,000 to 1,700 years ago; and Late Prehistoric, 1,700 to 300 years ago (Zeimens and Walker 1977). This chronology is summarized in Table R2-20.

Within the region, about 200,500 acres have been inventoried by professional archeologists, representing a 4% nonrandom, nonstratified sample. Not all environmental zones identified in the region are represented in this sample, nor have excavations been conducted on a representative number of sites. These inventories have identified 246 sites, most of which are on lands covered by approved mining plans. During each plan's review, the significance of individual sites involved has been assessed, and adequate stipulations developed for the recovery of archeological data. Archeological evaluation has indicated that all available data has been recovered from 120 known sites (Zeimens and Walker 1977). Complete information has yet to be recovered from 126 sites. Cultural affiliation has been assigned to 29 sites in the region based on projectile point types on 25 sites, on carbon-14 (C-14) dates at 3 sites, and on pottery types found at 1 site. Some sites represent more than one period. Nineteen Late Prehistoric period sites have been identified by diagnostic projectile points and 3 others by C-14 dates. Five of these sites also contained diagnostic materials indicating earlier occupation. Nine sites representing the Late Plains Archaic period have been identified, 1 by a C-14 date, and 8 others based on diagnostic

TABLE R2-19

REPTILE AND AMPHIBIAN DENSITY ESTIMATES (NUMBERS/ACRE) BY VEGETATIVE TYPE FOR THE EASTERN POWDER RIVER BASIN

	VEGETATIVE TYPE					
SPECIES	Grassland	Sagebrush	Conifer (Ponderosa Pine)	Riparian*	Greasewood	Aquatic
Tiger salamander	0-5	0-5		.1-30		.1-200
Plains spadefoot toad	0-10	0-10		0-5		
Great Plains toad	.01-2	.01-2		.01-1		
Rocky Mountain toad	.02-2	0-1		.05-10		
Boreal chorus frog				0-70		0-70
Bullfrog						0-20
Leopard frog				0-20		0-20
Northern sagebrush lizard		1-30				
Eastern short-horned lizard	.1-10	.1-10	0-1		.05-5	
Prairie rattlesnake	.08-.3	.06-.1	0-.06	.08-.3	0-.06	
Plains hognose snake	.05-.2	.02-.08		.05-.2		
Eastern yellow-bellied racer	.08-.3	.05-.3	0-.06	.1-.5		
Western smooth green snake	0-.05		0-.02	.005-.1		
Bullsnake	.1-.5	.05-.3	0-.15	.1-.5	0-.1	
Pale milk snake				0-.1		
Western plains garter snake	0-.2			.05-20		
Wandering garter snake	0-.1			.05-20		
Snapping turtle						0-15
Western spiny soft-shelled turtle						0-10
Western painted turtle				0-10		0-100

Data from Wyoming Game and Fish Department (1978) under Contract No. YA-512-CT8-126.

* Includes figures for meadow types.

TABLE R2-20

CHRONOLOGICAL SEQUENCE FOR NORTHWEST PLAINS

Period	Date B.P. (before present)	Projectile Point Style or Cultural Group Northeast Wyoming	Evidence Eastern Powder River Basin
Ethnohistoric	300 to 100 years ago	Teton Dakota (Sioux) Arapaho Cheyenne Crow Shoshone	Historic record
Late Prehistoric	1,700 to 300 years ago	Comanche Shoshoni Plains Apache Kiowa Crow Avonlea projectile points	Ethnographic information Pottery from 1 site Surface evidence from 22 sites 48 CA 7, 1,320 ± 100 BP 48 CA 56, 1,590 ± 110 BP 48 CA 302, 1,670 ± 135 BP
Late Plains Archaic	3,000 to 1,700 years ago	Corner-notched projectile points	One excavated site Surface evidence from 9 known sites 48 CA 104, 2,040 ± 90 BP
Middle Plains Archaic	5,000 to 3,000 years ago	McKean	Surface evidence from 1 site
Early Plains Archaic	7,500 to 5,000 years ago	Large side-notched projectile points	Surface evidence from 1 site
PaleoIndian	11,200 to 7,500 years ago	Eden Hell Gap Agate basin Folsom Clovis	One buried site Surface evidence from 2 sites Private collections

Source: Zeimens and Walker 1977

projectile points. The Middle Plains Archaic and Early Plains Archaic periods are represented by diagnostic projectile points recovered from 1 site. The Paleo-Indian period is represented by 3 sites. One is an Eden bison kill site where excavations and analysis are in progress by the University of Wyoming. Hell Gap points were recovered from the other 2 sites during inventory investigations. Analysis of known sites and private artifact collections indicates that a complete temporal range of occupation is present in the region. Unfortunately, much of the evidence is in the form of isolated surface finds, and not sites with buried cultural materials needed to establish a better chronology for the region. As individual sites are fully studied, more complete data will become available.

Identified sites can be divided into ten categories: (1) stratified sites, (2) bone beds, (3) stone circles, (4) rock art, (5) burials, (6) rock shelters, (7) ceramic sites, (8) quarries, (9) fire pit sites, and (10) concentrations of worked lithic (tool stone) material. Presently 4 stratified sites have been identified, but none has been fully studied. There are 6 sites known to contain buried levels of bison bone as well as definite cultural materials. One of these (the Ruby site) has been excavated and reported, and 2 others have detailed excavations and analysis in progress. Forty-three sites contain stone rings or tipi rings. Only 1 rock shelter containing evidence of occupation has been identified, and only 2 rock art sites are known. The 1 recorded prehistoric burial was presented to the University of Wyoming in a cardboard box and is thus of little archeological value. Ziemens and Walker (1977) reported 5 sites known to contain ceramics, unfortunately, none of the sites has provided ceramics in definitive context. The 13 tool-stone quarries which have been recorded are located on gravel-capped ridgetops where tool stone was gathered from the surface; no evidence of excavation or quarrying to recover tool stone has been identified. The remaining sites consist of concentrations of worked lithic material or evidence of fire pits.

Until more studies are conducted, the actual significance of these sites cannot be evaluated. As further archeological work progresses, more sites within each category will be identified. Many known sites are deeply buried and are only discovered because of modern arroyos. Isolated bison bones which may date to 10,000 years ago are found exposed 10 to 15 feet below the surface in some arroyos. Thus much of the evidence for occupation is not evident on the surface.

Archeological investigations have provided the information needed to make a number of assumptions concerning settlement pattern or prehistoric site locations within the region. Since these assumptions are based on limited data, they are very general. As ongoing work is completed, more information will become available on settlement pattern systems within each temporal period. The first assumption is that the greatest site density should be in areas with the greatest diversity of wildlife and vegetation along major drainages or in areas of greatest topographic relief. A major problem, however, is that these areas have the least chance of being exposed due to soil deposition, which may be 10 to 15 feet thick, and vegetative cover. Site density should be the lowest in large, flat, open grasslands with little topographic relief; however, these areas have the greatest chance of discovery. In areas of high site density, much of the evidence for prehistoric occupation will only be identified when vegetative cover and topsoil are removed.

Due to the small sample of fully excavated sites in the region, no one time period or cultural affiliation is more significant than another. Any site containing datable cultural materials is very significant in the Eastern Powder River Basin.

Ethnohistoric

Material remains of tribes who occupied the Eastern Powder River Basin are studied along with other archeological sites when identifiable. Available ethnographic data allows some tribal identification from A.D. 1400 until A.D. 1880, although actual historic accounts are very scanty before 1850. Tribal distribution and density can be seen as a series of population movements drawn onto the plains by high bison populations and away from the plains in years of low bison populations. The grasslands have dominated the central North American continent for thousands of years, "...sighing to the periodic rhythm of changes in rainfall, luring peoples out with the promise of incredibly rewarding hunting, only to dry and expell them again"(Reher, from Zeimens and Walker 1977, p. 135).

Reconstructed tribal distributions are presented in Figures R2-21 through R2-24. Actual physical evidence of these occupations should become evident as additional archeological investigations are conducted.

Historic

The first traveler known to have entered the region was Francois Antoine Larocque of the Northwest Company who entered the northwest corner of Campbell County on August 2, 1805, while traveling up Powder River. The bulk of his travels were in Montana, and no sites related to this exploration have been located.

The second known party and the first to have a direct effect upon later activities was the group of American Fur Company "Astorians"who crossed northern Campbell County in August of 1811. Their journey followed the divide between Powder River and the Little Missouri; however, no physical evidence of their presence has been recognized.

Robert Stuart led the returning "Astorians"in 1812 and is credited with the discovery of the North Platte-South Pass transcontinental land route best known as the Oregon Trail. This trail served as a major transcontinental route until 1862, and still retains national importance.

Pack trains of traders and trappers moved frequently over the Oregon Trail in the 1820s and 1830s. In 1842, they took the first wheeled vehicle, a four-pounder cannon, over the route. Soon, trade caravans regularly

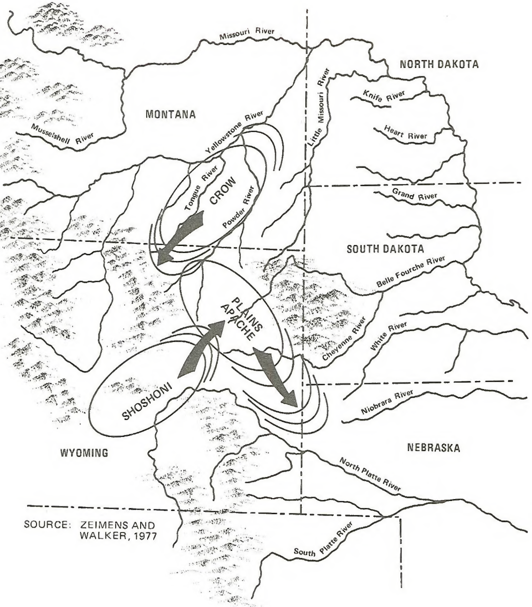


Figure R2-21
TRIBAL DISTRIBUTION OF THE POWDER RIVER BASIN, A.D. 1400 - 1600

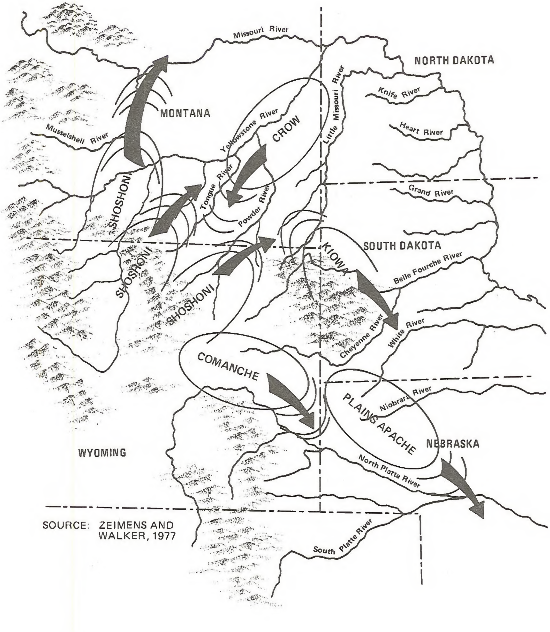


Figure R2-22

TRIBAL DISTRIBUTION OF THE POWDER RIVER BASIN, A.D. 1600 - 1700

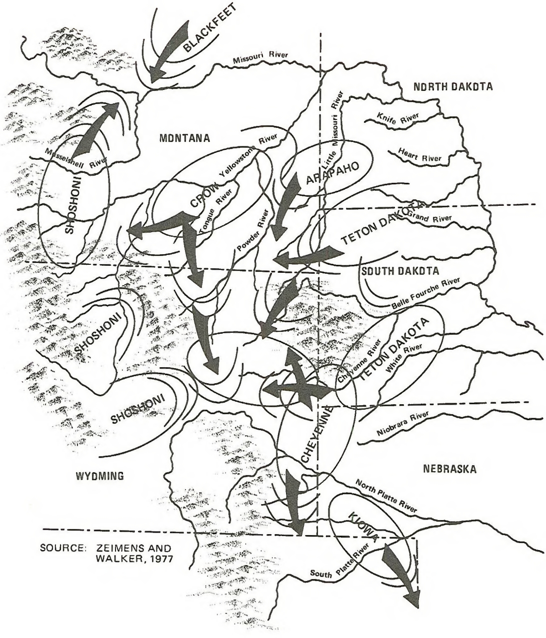


Figure R2-23
TRIBAL DISTRIBUTION OF THE POWDER RIVER BASIN, A.D. 1700 - 1800

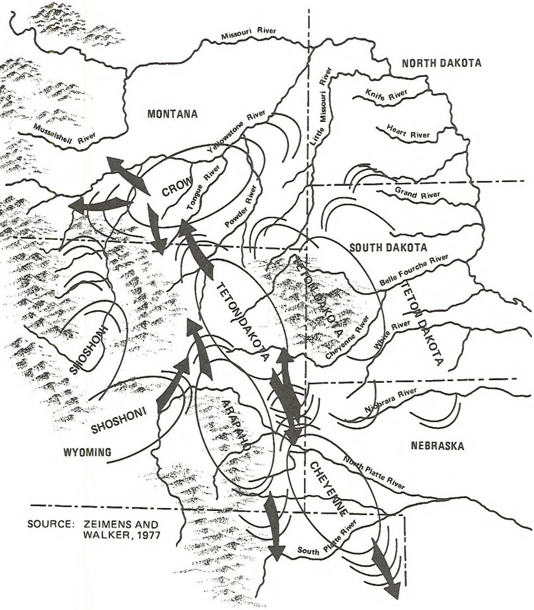


Figure R2-24
TRIBAL DISTRIBUTION OF THE POWDER RIVER BASIN, A.D. 1850

included a variety of carts and wagons. By the time frontier farmers developed an interest in settling the valleys of Oregon and California, the route was well known and marked by signs of travel.

The first party of settlers to California followed the trail in 1841, those to Oregon in 1842, the first Mormon settlers to Utah in 1847, and the California gold miners in 1848. As these travelers poured over the route, trading posts, ferries, and toll bridges prospered.

A transcontinental mail route operated from 1856 to 1858. The main overland stage line used this route from 1858 to 1862. The short-lived Pony Express of 1860 to 1861 passed here also, along with the first transcontinental telegraph line of 1861 to 1867. Each of these systems used some of the old trading posts as stations and established some new ones.

Extensive government surveys from 1856 to 1859 developed alternate routes up the South Platte, through lower portions of the Laramie Range and across southwestern Wyoming. The stage line moved to a new southern route (the Overland) in 1862. Few emigrants took the old route after 1862 until the region itself began to be settled in the late 1870s.

The Oregon Trail did, however, serve as a main transportation route for military operations, when the army assumed responsibility for a series of operations in Powder River country.

All of this activity from 1812 to 1865, plus later supportive operations against the northern Indians, left a concentrated band of historic trails and sites along the North Platte River.

By 1863 the gold discoveries in Montana had caused a gold rush. In that year John Bozeman and John Jacobs set out to "pioneer"a wagon route to more directly connect the eastern side of the Montana gold area with the Oregon Trail and the eastern states. They publicized a route which linked known Indian, trapper, and explorer trails; it fronted the Big Horn Mountains and would allow wagons from the Oregon Trail to enter Montana without traversing the mountains (Map 12, Appendix A). Bozeman attempted to pilot one train over his trail in 1863, but it met hostile Indians at Clear Fork of Powder River and turned back. Four trains went through in 1864.

Meanwhile, by January of 1865, the government considered construction of a transcontinental railway a matter of prime national interest (Murray 1974). A plan soon developed to keep the Indians busy in their own country, well away from the projected railroad line. The first step was General Connor's punitive expedition into the Powder and Tongue River country, in the fall of 1865.

During Connor's activities, a civilian contractor, James Sawyer, was commissioned to lay out a wagon road from the mouth of the Niobrara River to connect with the Bozeman Trail at Powder River. Sawyer's column did a minimum amount of actual road building and theirs was the only wagon train to ever use the route.

In 1866, the government sought to pacify as many tribes as possible through presents and negotiations at Fort Laramie, while expanding its diversionary efforts and answering demands of Montana settlers by sending a force of regulars to garrison Fort Reno and to build at least two new posts along the Bozeman Trail.

Notable engagements were fought at Crazy Woman Creek and at Fort Phil Kearny. The best known is the Fetterman disaster in which Captain Fetterman led 81 men to their deaths in a Sioux and Cheyenne ambush less than 5 miles from the post. When skilled and seasoned combat veterans entered the picture they bested the Sioux in every skirmish, the most notable being the Wagon Box Fight of August 2, 1867. Several minor battles were also fought along the Bozeman Trail within the region.

When the rails were safely past Fort Fred Steele in southern Wyoming in July of 1868, the army quickly phased out its Bozeman Trail operations. From 1868 to 1876 there was not enough pressure for settlement of the high plains to warrant a major Indian campaign in the region.

In 1874, troops from the Department of Dakota escorted a government scientific expedition to explore the Black Hills. Commanded by Lt. Col. George Custer of the 7th U.S. Cavalry, the expedition reached the eastern portion of the region and camped near Inyan Kara Mountain.

Reports from the expedition launched a gold rush that precipitated war with the Sioux and Cheyenne in 1876. In these campaigns, primary operations were under the command of Brig. Gen. George Crook, commanding the Department of the Platte. Crook's operations substantially ended the Indian question as a serious military problem in what is now Wyoming.

With hostile Indians gone from the region by the spring of 1878, and the presence of the army insuring against their return, several changes rapidly took place. Construction activity during the summer of 1878 at Fort McKinney, and continued development at Fort Laramie and Fort Fetterman brought in additional freighters, supply contractors, and workmen. Many of these people stayed on to form the nucleus of settlement around each post.

Commercial buffalo hide hunters moved into the area and rapidly killed off animals remaining after 8 years of concentrated hunting by Indians between 1868 and 1876. Two hide-drying yards were operated along Powder River but their exact locations have not been identified.

Livestock was brought into the area along the North Platte by 1843, and each of the ferry stations, and later stage stations, maintained a small herd; actual cattle ranches were established in the 1870s along the feeder creeks south of the North Platte. Open range cattlemen, depending on eastern and foreign capital, rapidly filled the range by 1879, taking advantage of grazing resources no longer used by buffalo. This was a period of open range, rather than deeded land, a factor causing problems as the land was later homesteaded. Many of the open range operations used portions of the region; however, no major operations are known to have established home ranches within the area.

The Rock Creek Stage Company opened operations along the Bozeman Trail in 1877 to serve the growing

population. Four stations were constructed at watering points in the region. One was operated by Mike Henry at Brown's Spring. Other stations were constructed at Sage Creek, Sand Creek, and Antelope Creek. Shortly after stage operations began, a military telegraph was constructed along the Bozeman Trail.

After 1880, homesteaders began settling the bottomlands and water sources, forming small ranches not backed by outside capital, and holding title to their base operations. These small ranches came into conflict with the open range operations over use of open public lands, which led to the Johnson County War of 1892.

Railroads arrived late in the region. The Fremont, Elkhorn, and Missouri Valley Railroad (later part of the Chicago and North Western system) reached the Douglas townsite on August 22, 1886 (Frary 1974). Lots were auctioned off on August 29, 1886, and Douglas became a town of 1,600 within 90 days (Murray 1974). The Burlington and Missouri Railroad extended its tracks across Campbell County, reaching the Gillette area in 1891. A tent town called Donkey Town was established for the construction men. Civil engineer Edward Gillette surveyed a shorter route which ran north of Donkey Creek and saved the expense of 30 bridges. For this service, the town which was established on Rock Pile Draw was named Gillette.

With rail service and the introduction of sheep to the region after 1891, homesteading began to take up most of the dryland areas and change the public range into private holdings. Both Douglas and Gillette became business centers for livestock shipping and homestead operations. The dry years and bad economic conditions of the 1930s were the final blows to many homesteaders, and the region's population decreased. During the 1930s, the federal government bought back many of the dryland homesteads and established the national grasslands system.

Some coal mining had been conducted on outcrops along the North Platte by Oregon Trail travelers. After railroads entered the region, several small coal operations developed, both along the Platte and in the Gillette area. Coal was mined in the Minturn district east of Gillette for local and railroad use. In 1923 the Peerless Mine was established on the Roland and Smith coal beds. The Wyodak Mine, established in 1922, is the oldest operating surface mine in the region. Large-scale coal development began in the 1970s.

The oil industry was active in the region by 1915. However, large-scale oil and gas activity did not develop until the 1950s.

Physical evidence of homesteads is present throughout the region, and varies from occupied homes to shallow depressions indicating former structures of some kind. Physical evidence of early coal and oil development is also present throughout the region.

National Register Sites

Presently, two sites within the Eastern Powder River Basin of Wyoming are listed on the National Register of Historic Places (*Federal Register* 1977): the Glenrock Buffalo Jump and Fort Fetterman, both in Converse County. In addition, numerous sites identified as eligible or thought to be eligible are listed by Wyoming's State Historic Preservation Officer. The listing is included in Appendix B.

VISUAL RESOURCES

The characteristic landscape of the Eastern Powder River Basin consists of open country: grass- and sage-covered plains, low hills, and scattered buttes. Water is rarely seen. Scattered areas of rough terrain supporting ponderosa pine and juniper, and red coloring in landforms provide occasional variety in the natural landscape. There are also areas of altered landscape in the basin, such as oil fields, urban areas, and mines.

Based on the Visual Resource Inventory and Evaluation System (U.S. Department of Interior, Bureau of Land Management Manual 6300), visual resource management (VRM) classes have been identified for Campbell and northern Converse counties. These classes are delineated on Map 8, Appendix A. An explanation of the VRM system and the analysis from which these classes have been taken appear in Appendix B. Figures R2-25 through R2-29 illustrate the characteristic landscape and VRM classes found in the region.

RECREATION RESOURCES

More than 75% of the land surface in the Eastern Powder River Basin is privately owned. Consequently, less public land is available for outdoor recreation than in other parts of Wyoming, and access to it is limited. The national forests and recreation areas on the fringes of the basin (Figure R2-30) absorb much of the recreation pressure created by local residents. Visitor use data are shown in Table R2-21 and in Appendix B.

A common unit of measurement for recreation is a visitor day which represents 12 hours in one activity. Three people canoeing together for 4 hours totals one visitor day.

Hunting

The big game hunting resource of the Eastern Powder River Basin is of national significance. Antelope, mule and white-tailed deer, and elk are the most plentiful and sought-after big game. Eighteen percent of the state's antelope harvest and 12% of the mule deer harvest occur in Campbell County. In 1976, 17,281 people hunted antelope within the Eastern Powder River Basin (Table R2-22), representing 42,529 hunter days. Nearly 85% of the antelope hunters were nonresidents. Deer hunters in the basin numbered 11,298, representing 41,933 hunter days. Over 67% of the deer hunters were nonresidents. Elk, which are not as abundant as antelope and deer, were hunted by 120 people, representing 432 hunter days.

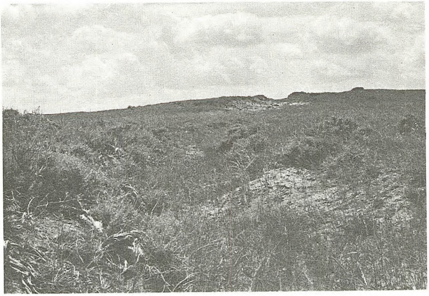


FIGURE R2-25

BOZEMAN TRAIL RUTS--CLASS I

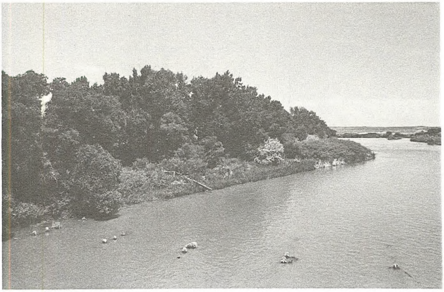


FIGURE R2-26

NORTH PLATTE RIVER--CLASS II

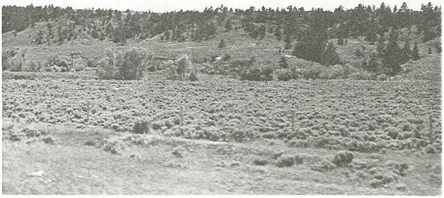


FIGURE R2-27

PINE-COVERED HILLS--CLASS III

FIGURE R2-28

ROLLING PLAINS--CLASS IV

FIGURE R2-29

INTRUSION--CLASS V

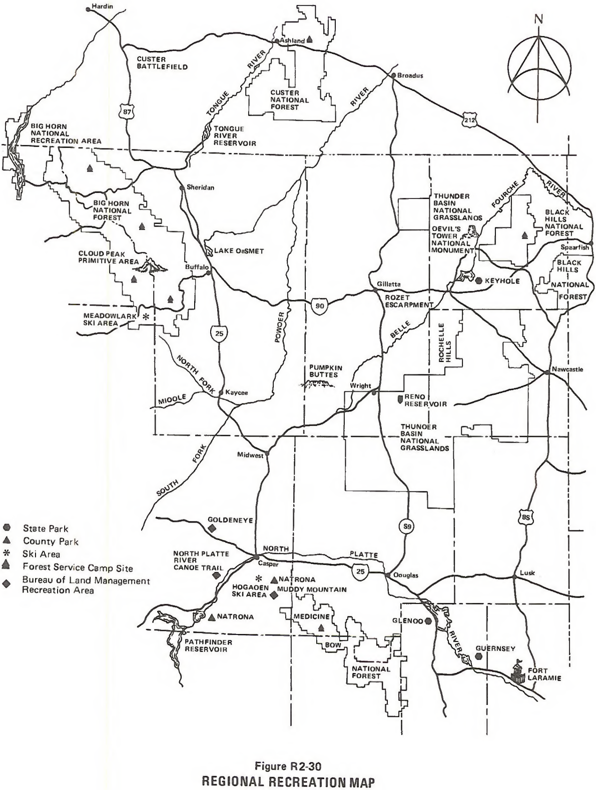


Figure R2-30
REGIONAL RECREATION MAP

TABLE R2-21

ESTIMATED RECREATION PARTICIPATION
CAMPBELL AND CONVERSE COUNTIES
1975

Activity	Number of Visitor Days
Camping, hiking, picnicking	320,000
Fishing	60,000
Hunting	46,000
Municipal sports*	224,000
Sight-seeing	157,000
Water sports	165,000
Winter sports	38,000

Source: Derived from Wyoming Recreation Commission 1975.
Note: No separate data for off-road vehicle use are available. Until recently, the Bureau of Land Management and the U.S. Forest Service have considered off-road vehicle use only as a part of other activities, such as hunting and fishing.

* Ice skating, softball, basketball, tennis, golf, and attending athletic events.

TABLE R2-22

HUNTING STATISTICS FOR THE EASTERN POWDER RIVER BASIN

Type of Game	Hunters	Recreation Days	Harvest	Success Ratio
Pronghorn Antelope (1976)	2,618 (resident) 14,663 (nonresident) 17,281	26,900	16,292	94%
Deer (1976) (Mule Deer and White-tailed Deer)	3,710 (resident) 7,588 (nonresident) 11,298	26,600	8,726	77%
Elk (1976)	106 (resident) 14 (nonresident) 120	300	76	63%
Waterfowl (1975)* (estimated)	614	2,200	3,699	4.8 birds per hunter
Upland Game Birds (1975)* (estimated)	556	800	2,692	4.9 birds per hunter
Small Game (1975)* (estimated)	614	1,800	5,452	8.9 animals per hunter

Source: Derived from personal communication, Harry Harju, Wyoming Game and Fish Department 1976

* Data are for Campbell County and all of Converse County.

Over 88% of the elk hunters were residents (personal communication, Harry Harju, Wyoming Game and Fish Department 1976). The number of small game hunters is low, because the areas where rabbits and game birds occur are primarily privately owned. Stock ponds and larger streams such as the North Platte River provide some fine waterfowl hunting in the late fall and winter.

Fishing

Because of the shortage of streams in the basin and the lack of public access to them or to stock ponds, sport fishing occurs mostly on large reservoirs such as Keyhole, Lake DeSmet, and North Platte River impoundments.

Winter Activities

Downhill skiing at developed commercial facilities within the recreation region is confined to Meadowlark ski area west of Buffalo in the Big Horn Mountains, Hogadon ski area near Casper on Casper Mountain, and Terry Peak northeast of Newcastle in the Black Hills. Areas for cross-country skiing in the mountains surrounding the basin are accessible from all-weather highways. In 1975, skiing by residents of the Eastern Powder River Basin accounted for 9% of the skiing in the recreation region (Wyoming Recreation Commission 1975).

Snowmobiling is a somewhat more significant winter activity. In 1975, snowmobiling by residents of the Eastern Powder River Basin accounted for 22% of the snowmobiling in the recreation region (ibid.). The primary areas for snowmobiling are the Big Horn Mountains, Black Hills, and Laramie Range, in that order.

Water-based Recreation

Water-based recreation is confined to the large reservoirs in and near the region. Keyhole, Glendo, Guernsey, and Alcova reservoirs offer good boating, water skiing, and swimming opportunities in spring and early summer (Figure R2-31). Drawdowns reduce the water levels and the opportunities for recreation in late summer. Residents of Campbell and Converse counties accounted for 21% of the recreation region's total participation in water-based activities in 1975 (ibid.).

Sight-Seeing/Historical Interest

The Eastern Powder River Basin itself has limited value for sight-seeing with the exception of wildlife viewing. On the periphery of the basin are Devils Tower National Monument (Figure R2-32), Pumpkin Buttes, and the Rozet Escarpment. These features and the red cinder cones and coal beds near Gillette provide evidence of the geologic history of the basin.

Visitor interpretive sites have been developed by federal, state, and local agencies and groups, describing the history of the Oregon and Bozeman trails. Those listed on the National Register of Historic Places include Fort Laramie, Fort Fetterman, Fort Phil Kearny, and the Sheridan Inn.

Significant archeological sites, such as the "Medicine Wheel"in the Big Horn Mountains, exist in the recreation region, but most sites are either inaccessible or unprotected from vandalism.

Camping/Picnicking

Except for municipal facilities, developed recreation sites within the Eastern Powder River Basin are minimal. Pumpkin Buttes in southwestern Campbell County is an undeveloped area used by local residents for hiking and picnicking. Most camping and picnicking is undertaken in the cooler mountains surrounding the basin or at major recreation areas, such as Devils Tower National Monument, or Keyhole, Glendo, or Guernsey State Park.

Collecting

Gem and mineral collecting is popular all across the Eastern Powder River Basin, Black Hills, and Big Horn Mountains, although the value of most minerals is insignificant. One exception is Tepee Canyon agate, a gem of nationwide reknown, from Tepee Canyon, 21 miles east of Newcastle. Petrified wood is also found throughout the region.

Off-Road Vehicle Use

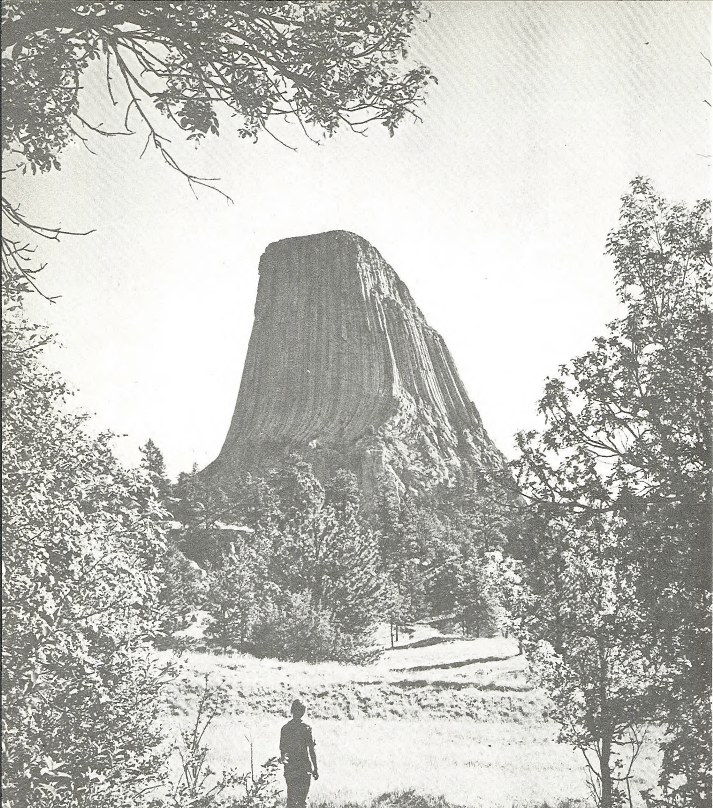
Approximately 35% of the people in Gillette own four-wheel drive vehicles, which are used for transportation on local roads and/or off-road vehicle (ORV) recreation. Dirt bikes are owned by 12.5% (University of Wyoming 1976). ORV use may occur in conjunction with hunting, fishing, or sight-seeing, or simply on overland trails and dirt tracks. A major problem already confronting ORV users is the small amount of public land and restricted access to that land in the Eastern Powder River Basin. Consequently, those public lands that are accessible are suffering ORV damage in the form of soil compaction and vegetation destruction. Trespassing on private land is another problem that results. In order to alleviate some ORV user/landowner conflicts near Gillette, the Campbell County Parks and Recreation Department has made application to the Bureau of Land Management (BLM) for a tract of public land near Gillette to develop an ORV/motorcycle area.

Snowmobiling is a winter ORV activity. (See Winter Activities, above.)

(Photo courtesy of Wyoming Travel Commission)

FIGURE R2-31

KEYHOLE RESERVOIR



(Photo courtesy of Wyoming Travel Commission)

FIGURE R2-32

DEVILS TOWER

FIGURE R2-33

CAMPING IN THE LARAMIE MOUNTAINS
MEDICINE BOW NATIONAL FOREST

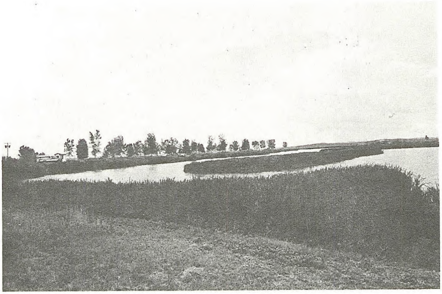


FIGURE R2-34

GILLETTE FISHING LAKE

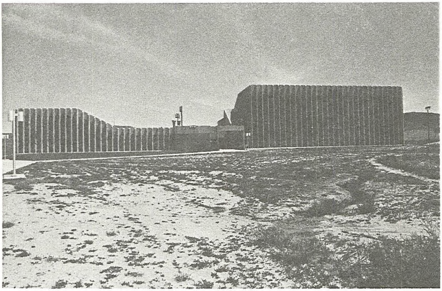


FIGURE R2-35

DOUGLAS COMMUNITY RECREATION CENTER

Wilderness Values

The only existing primitive area in the recreation region is the Cloud Peak Primitive Area in the Bighorn National Forest. There are proposals to expand the primitive area and make it a part of the National Wilderness System. One wilderness study area, Ashenfelder, consisting of 26,500 acres, has been identified in the Laramie Mountains of the Laramie Peak Division, Medicine Bow National Forest. There are also four roadless areas in the Laramie Mountains: Deer Creek, 14,500 acres; Buffalo Peak, 8,000 acres; LaBonte Canyon, 23,200 acres; and Eagle Peak, 12,000 acres.

BLM has initiated a wilderness study of public lands it manages in Campbell and Converse counties to comply with Section 603 of the Federal Land Policy and Management Act of 1976. It is unlikely that any land eligible for wilderness designation will be identified, primarily because the public land occurs in small isolated tracts.

The Fortification Creek area on the Campbell-Johnson county line has been identified as a potential natural area.

Municipal Recreation

The communities of Gillette, Douglas, and Wright are experiencing increasing pressure for close-to-home recreation. In Campbell County, the city of Gillette and the Campbell County Parks and Recreation Department provide parks, recreation facilities, and recreation programs for all ages. The county department is supported by a county-wide mill levy. The new community of Wright, which is being developed by Atlantic Richfield Company (ARCO), has a softball field for residents, and ARCO has announced plans for development of additional recreation facilities.

In 1974, Gillette and Campbell County were considered up to national recreation standards in most aspects (Campbell County Recreation Study 1974). However, the most pressing problem facing the county recreation department has been the acquisition of satisfactory park land as Gillette expands. Through recently enacted subdivision regulations, the department is receiving dedicated park land which is helping to alleviate this shortage. Table R2-23 reports the perceived needs (as of April 1976) for additional recreational facilities in Gillette by order of priority.

In Converse County, the Converse County Park Commission operates the county's two parks in the southern part of the county. The commission has no plans for expansion of the county park system at this time. In Douglas and Glenrock, the recreation programs are operated in conjunction with the school district. Douglas has a new indoor facility which has a swimming pool and handball courts; the city of Douglas operates a system of parks.

AGRICULTURE

Throughout its settled history, the region's dominant economic activity has been dryland ranching, despite recent active mineral developments. Agricultural exports, mainly beef, presently constitute the largest nonenergy export industry of the area.

Livestock Grazing

Production of range beef cattle and sheep is the predominant land use within the region. An estimated 94% of the land within Campbell and Converse counties is used as rangeland. The 1969 Census of Agriculture (U.S. Department of Commerce) indicates that 793 ranch operations are present within the two-county area. The average ranch is 7,276 acres and carries approximately 262 animal units (one cow, one horse, or five mature sheep constitute one animal unit). Most ranches are reasonably well contained in contiguous ownership patterns. A few ranches in western Campbell County move sheep and cattle from winter range to summer range holdings in the southern Big Horn Mountains. Based on federal grazing lease statistics, 59% of the ranches are cattle operations, 14% are sheep operations, 25% both sheep and cattle, and the remaining 2% are ranches and farms with dairy cattle, horse, or buffalo operations. According to the Wyoming Crop and Livestock Reporting Service (U.S. Department of Agriculture 1978), there are 132,000 cattle and calves and 180,000 sheep and lambs in Campbell and Converse counties. Many livestock operations have been shifting from sheep to cattle in recent years for economic reasons. Other classes of livestock contribute little to total production within the region.

Many of the ranch operations rely on leased lands to maintain size of operations at a desired economic level. Federal and state lands are the major component of leased lands. (Within Campbell and Converse counties, land ownership is distributed as follows: private, 79%; Bureau of Land Management public lands, 7%; national forest lands, 6%; and state and local lands, 8%.) Some ranch consolidation is taking place and industrial concerns have been acquiring ranches.

Grazing use of the range may be either seasonal or yearlong, depending on the management system established on the specific tract. Winter forage is a critical limiting factor to the livestock industry in the region. Sheep ranchers rely on native range to winter the livestock. During severe winters they supplement feed with native hay and/or purchased protein concentrates. Cattle are generally wintered near ranch headquarters and are maintained on locally grown hay as well as protein supplements. During the summer months, livestock are moved to summer rangelands.

Livestock distribution and use of available range forage is affected by water availability. Livestock water impoundments and wells are important since little natural water exists in many parts of the region. Streams are limited and most are intermittent. Control of livestock on the range is primarily by fencing for cattle and by both herding and fencing for sheep. Other facilities necessary

TABLE R2-23

PERCEIVED NEED FOR RECREATIONAL FACILITIES
EXPRESSED BY GILLETTE RESIDENTS

Facility	Amount of Need		
	Very Great Or Great	Moderate	Low or None
Parks	80.7%	12.6%	6.7%
Playgrounds	78.2%	16.8%	5.0%
Youth Center*	75.3%	16.4%	8.4%
Senior Citizen's Center*	69.7%	20.2%	10.1%
Ice Skating Rink	62.1%	22.1%	15.8%
Roller Skating Rink	59.6%	24.2%	16.3%
Gymnasium	58.7%	23.8%	17.5%
Ball Fields	52.4%	30.2%	17.4%
Indoor Swimming Pool	50.4%	16.2%	33.4%
Bowling Center	49.8%	26.6%	23.6%
Tennis Courts	49.2%	31.1%	19.7%
Handball Courts	36.4%	34.3%	29.3%
Motorcycle Track	33.7%	30.4%	35.9%

Source: University of Wyoming 1976.

* Since this study was completed, the Campbell County Parks and Recreation Department has opened both a youth center and senior citizen's center.

for livestock management on the range include corrals, stock driveways, access roads, and ranch facilities.

Farming

The Eastern Powder River Basin is not noted for extensive farming activities. Farming occurs on 2.5% of the land area in Campbell and Converse counties. Hay and forage are the major crops raised within the region because of livestock industry needs and prevailing climatic conditions. Most farming is conducted by livestock operations, and hay is used locally. Hay production is not sufficient to provide total winter forage requirements. Most operations rely on native range to winter livestock. (In many cases, hay is saved and used only during critical winter periods as prices in the market reach premium levels.)

Most of the hay is produced on irrigated meadows along the North Platte River and, to a lesser extent, on dryland farms in Campbell County. Both alfalfa and grass hay are grown, but alfalfa is predominant on the irrigated meadows.

Irrigated farmlands are primarily limited to Converse County. The number of acres under irrigated crop production has been rising gradually over the years but is limited by the availability of water. Projected water requirements for irrigation (10,000 acre-feet per year) show no change for the period 1978 through 1990 (Table R1-8). Adequate water would be available for minimal increases in irrigation, based on recharge rates of the water table (see Water Resources, Chapter 4).

Dryland farming is the primary farming practice in Campbell County due to lack of irrigation water. The most successful dryland farm areas in the region are located in northern Campbell County, from Gillette northward, where annual precipitation is 14 to 17 inches. Dryland farming south of Gillette has proven to be marginal to submarginal over an extended time period.

Dryland farming acreages change from year to year, reflecting market fluctuations and weather conditions. The last four decades have shown wide variability in acreages, crop yields, and success. During Wyoming's early homesteading era from 1920 to 1930, large acreages of semiarid lands were being tilled. The final chapter of homestead development was written in dust storms and ruined lands when droughts occurred on the area. Many of these lands were reacquired by the federal government under the National Industrial Recovery Act of 1933, Emergency Relief Act of 1935, and Bankhead-Jones Act of 1937. Most of these lands are currently included in the Thunder Basin National Grasslands.

Total dryland cropland decreased over the years as submarginal lands were retired from cultivation, because the land proved to be more valuable and suitable for livestock grazing. During the past few years, some of these lands have again been placed into crop production in response to government farm programs and rises in grain prices.

Agricultural lands must meet certain requirements of the Surface Mining Control and Reclamation Act (SMCRA) to be considered prime farmland. These requirements include such factors as proper soils, a history of cropping, land slopes, and irrigation systems in areas with less than 14 inches of annual precipitation. Prime farmland is probably present in the region, but is expected to be a minor component of the agricultural lands. No formal designation of prime farmland has yet occurred in the region. Agricultural lands on each proposed mine site will be analyzed on a site-specific basis to determine if they meet the SMCRA requirements for prime farmland.

FOREST RESOURCES

Ponderosa pine is the only commercial timber species existing in the Eastern Powder River Basin of Wyoming. It is confined primarily to ridges, escarpments, plateaus, benches, and rolling hills which rise above the surrounding plains. It occurs in small scattered patches. On the poorer sites it is found in association with Rocky Mountain juniper.

Generally, the trees are of poor quality: they are short and limby. Good stands of sawtimber-size trees are scattered throughout the areas, but economical harvesting is limited at the present time by transportation costs. Stocking (the number of trees per acre) is rated as poor.

History of the timber areas indicates limited use in the past. Use consisted primarily of products needed for homesteads, ranch accessories, and fuel. With the exception of minor products such as boughs, cones, wildings, posts, and poles, there is little present demand for forest products.

In the context of the surrounding plains area, the ponderosa pine forests are considered more important for wildlife habitat and recreation use, particularly hunting, than for wood fiber.

MINERAL RESOURCES

Coal development, both present and proposed, uranium mining projects and mills, and selected oil and gas fields are shown on the regional activity map (Map 1, Appendix A). Energy resources are also shown on Map 10, Appendix A.

Coal

The Eastern Powder River Basin lies within the Powder River Coal Basin and includes all or part of nine coal fields as defined by the Geological Survey (Figure R2-36).

Minable (under less than 3,000 feet of overburden) coal deposits underlie more than 90% of the region. The coal is all of subbituminous rank except for a small deposit of lignite in northern Campbell County (Figure R2-36). According to Breckenridge and others (1974), 50.4% of Wyoming's remaining minable coal resources and 84% of its known strippable (under less than 200 feet of overburden) coals are in Campbell County. Campbell County

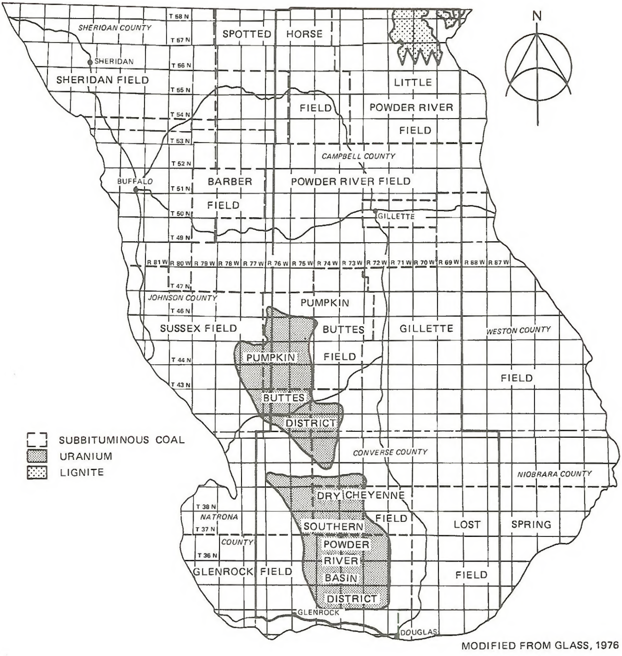


Figure R2-36
COAL FIELDS AND URANIUM DISTRICTS IN THE POWDER RIVER BASIN

also ranks first in the nation for reserves in a single county (Smith et al.). Known strippable coal deposits and related energy development in the Powder River Coal Basin are shown in Figure R2-37. Total identified original minable coal resources for the region are 73,187.81 million tons (Glass 1976). Of this, 69,033.84 million tons are in Campbell County and 4,153.97 are in Converse County. Available data on coal resources by county and field are shown on Table R2-24.

The coal of the region is low sulfur and thick bedded, and a large part of it is strippable, making it an important national resource.

Coal is presently being produced from ten mines in the region (Figure R2-37). Nine mines (Rawhide, Wyodak, Belle Ayr, Caballo, Cordero, Black Thunder, Jacobs Ranch, Eagle Butte, and Kerr-McGee #16) in the Powder River and Gillette fields produce from the Wyodak seam at or near the top of the Fort Union Formation. This bed has the largest tonnage of coal in a single continuous bed anywhere in the United States (Averitt 1975). Pacific Power and Light's Dave Johnston Mine in the Glenrock Coal Field produces from the School and Badger seams, considered in this ES to be in the lower 200 feet of the Wasatch Formation. (Correlation of the School and Badger seams with other coals in the region is not clear (Glass 1976), and Glass places them in the top of the Fort Union Formation.)

As of January 1, 1975, 19.2 million tons of coal had been produced from Campbell and 25.18 from Converse County totaling 44.38 for the region (ibid.). This represents .2% of the total original estimated strippable resources (Table R2-24) and .06% of the total original estimated minable resources for the region.

Oil and Gas

Oil and/or natural gas have been discovered in more than 200 fields (Figure R2-38) within the region, and active exploration continues. Most of the fields produce from either the Muddy Sandstone of Cretaceous age or the Minnelusa Formation of Pennsylvanian age or from both. The Cloverly Formation of early Cretaceous age is also an important producing horizon and lesser amounts of oil and/or natural gas come from Sundance, Morrison, Mowry, Turner, Niobrara, Shannon, Sussex, Parkman, Ferguson, and Teapot sandstones (Figure R2-7).

From the first significant oil discovery at Big Muddy Field in 1916 until January 1, 1973, production has been more than 400 million barrels of oil and about 400 billion cubic feet of gas. The remaining recoverable reserves in the region are conservatively estimated at more than 200 million barrels of oil and more than 500 billion cubic feet of natural gas.

Of the known fields, 166 are actively producing and 44 fields are classified as temporarily nonproductive. A majority of the nonproductive fields are shut in, waiting for secondary or tertiary recovery procedures to be implemented, being considered for reactivation, or in the process of activation.

The average area used by oil well facilities including pumper, separator, ponds, pipelines, and access roads, does not exceed 15 acres per square mile. Where several wells share land facilities or are developed with wide spacing, the area required is less than 5 acres per square mile.

Uranium

Ore-grade uranium occurs in two mining districts in the region: the Pumpkin Buttes district in Campbell, Converse, and Johnson Counties, and the Southern Powder River Basin district in Converse County (see Figure R2-36). Host rocks for uranium ore in the Pumpkin Buttes district are sandstones in the Wasatch Formation. In the Southern Powder River Basin district the ore occurs in sandstone in the upper part of the Fort Union Formation and in sandstones in the Wasatch Formation.

The uranium industry of Wyoming began in the Pumpkin Buttes district with the discovery of ore-grade uranium in 1951, and the first commercial production began in 1953. Early mining was for high-grade deposits at or near the surface, from pits generally less than 100 feet deep and less than 5 acres in extent. Between the years 1953 and 1967, 36,737 tons of ore containing 208,143 pounds of uranium (U_3O_8) were mined from 55 mines in Campbell County (Breckenridge et al. 1974). By the late 1960s accelerated exploratory activity resulted in discovery of significant ore bodies in the Southern Powder River Basin district.

Uranium is not now being mined in the Pumpkin Buttes district, but three mines (Morton Ranch, Rocky Mountain Energy's Bear Creek and Exxon's Highland) are producing in the Southern Powder River Basin district from open pits, and Exxon has begun development of underground mines (Dahl and Hagmaier 1976).

It has been estimated that the Powder River Basin resources are 185,000 tons of U_3O_8 (Curry 1976). The 1978 value of U_3O_8 is $40 per pound (personal communication, Geological Survey, Uranium and Thorium Branch 1978).

The Pumpkin Buttes district is west of most strippable coal. Strippable coal deposits extend into the Southern Powder River Basin uranium district and here uranium deposits could exist in overburden or beneath minable coal. No uranium deposits are known that conflict with active or planned coal mines.

Scoria (Clinker)

Scoria, a reddish baked or fused stone formed in overlying strata when a coal seam burned, is widespread throughout the eastern part of the region (Breckenridge et al. 1974). It is used for road surface material, railroad ballast, and construction stone. Scoria as much as 50 feet thick has been reported. Although no data are available on actual reserves, they are estimated to be in the numerous billions of cubic yards, several billion cubic yards re-

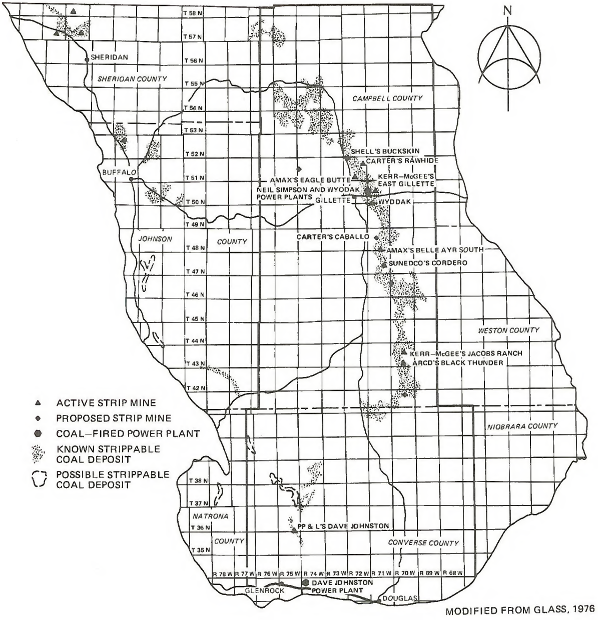


Figure R2-37

COAL RESOURCES AND DEVELOPMENT IN THE POWDER RIVER BASIN

TABLE R2-24
IDENTIFIED ORIGINAL ESTIMATED COAL RESOURCES IN THE EASTERN POWDER RIVER BASIN
IN MILLIONS OF SHORT TONS

	Total Minable (under less than 3,000 feet overburden)		Total Strippable (under less than 200 feet overburden) by Formation and Bed		
	Subbituminous	Lignite	Formation	Bed	Subbituminous
Campbell County	69,033.84	Present but no estimate of resource	-	-	-
Spotted Horse Field (part)	-	-	Wasatch	Felix	480.7
			Fort Union	Smith	178.0
				Local	58.3
				Canyon (E)	184.9
Little Powder River Field	-	Present but no estimate of resource	Fort Union	Smith	Included in Spotted Horse
Powder River Field	-	-	Wasatch	Felix	Included in Spotted Horse
			Fort Union	Smith	Included in Spotted Horse
				Wyodak	Included in Gillette
Pumpkin Buttes Field (part)	-	-			-
Gillette Field	-	-	Wasatch	F	179.5
			Fort Union	Anderson	250.0
				Canyon	250.0
				Wyodak	18,998.8
Sussex Field (part)	-	-	Wasatch	F	Included in Gillette
			Fort Union	"Lower"	13.6

TABLE R2-24
(cont'd)
IDENTIFIED ORIGINAL ESTIMATED COAL RESOURCES IN THE EASTERN POWDER RIVER BASIN
IN MILLIONS OF SHORT TONS

	Total Minable (under less than 3,000 feet overburden)		Total Strippable (under less than 200 feet overburden) by Formation and Bed		
	Subbituminous	Lignite	Formation	Bed	Subbituminous
Converse County	4,153.97	-	-	-	-
Gillette Field (part)	-	-	-	-	See Gillette above
Sussex Field (part)	-	-	-	-	See Sussex above
Dry Cheyenne Field	-	-	Wasatch	F	Included in Gillette
Glenrock Field (part)	-	-	Wasatch (?)	Badger School	9.5 114.7
Lost Spring Field (part)	-	-			-
TOTAL	73,187.81	Present but no estimate of resources			20,708.00

Source: Glass 1976, 1976a

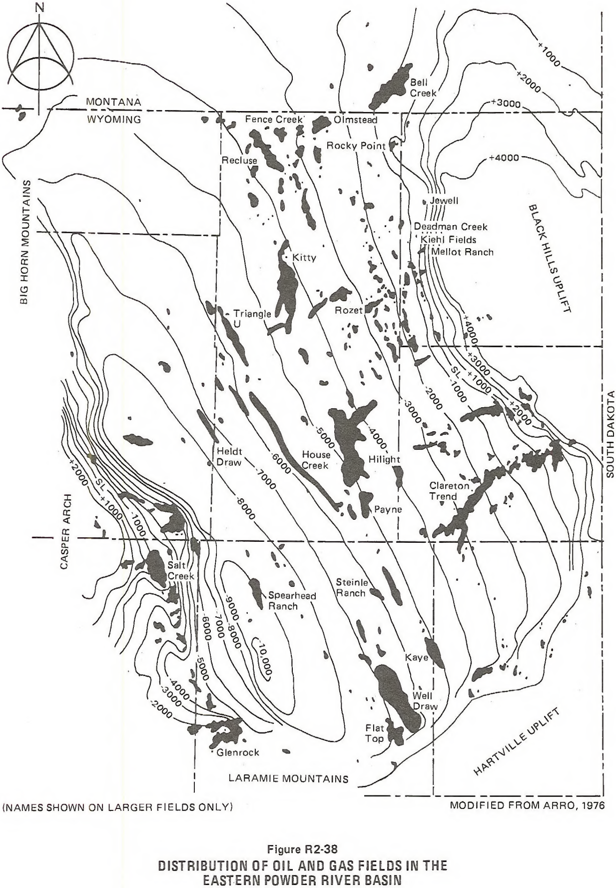


Figure R2-38
DISTRIBUTION OF OIL AND GAS FIELDS IN THE EASTERN POWDER RIVER BASIN

portedly underlying parts of T. 49 and 50 N., R. 70 and 71 W. (Dobbin and Barnett 1927).

Sand, Gravel, and Shale

Sand and gravel suitable for construction purposes is scarce in Campbell and Converse counties except for the North Platte River terrace deposits along the southern boundary of the region. Here the Wyoming Highway Department has identified several deposits containing not less than 25,000 cubic yards of sand and gravel. Scattered local deposits as much as 10 feet thick with pebbles up to 2 inches in diameter are found along some of the major streams within the basin. Extensive deposits of windblown sand occur in the southwest corner of the region.

Shale for local use as road surface material is quarried from the Potter shale pit about 3 miles from Gillette.

TRANSPORTATION NETWORKS

Rail Transportation

This section reviews changes in the amount and composition of rail freight transported on the Burlington Northern Railroad in recent years. These changes have affected Eastern Powder River Basin communities situated along the railroad, as well as communities beyond the boundaries of the region. The communities discussed here were selected for analysis on the basis of (1) location along major coal train routes, (2) degree of impacts, and (3) population size. Smaller communities (those under 1,000 population) are not analyzed explicitly, but the problems they experience are similar in nature.

Coal and Other Freight Train Traffic

Burlington Northern (BN) owns the only main line track available for transporting coal from the Eastern Powder River Basin. The estimated rail traffic capacity of this main line varies from 40 to 65 trains per day, depending on the addition of capital improvements such as centralized traffic control systems, additional sidings, and the completion of the Gillette to Douglas main line. Current traffic levels shown in Table R2-25 represent about 40% to 60% of available capacity.

Table R2-26 summarizes commodity statistics for coal and noncoal freight tonnage originating in Wyoming on the BN main line. (Freight traffic originating outside Wyoming and carried through the state is not included in these statistics.) During the time period shown, total freight traffic increased 364%, while coal traffic increased by 915%. Almost all of the increase in coal freight can be attributed to coal from the Eastern Powder River Basin. Noncoal tonnage remained fairly level at about 2 million tons throughout the time period shown.

Estimated 1978 coal production and unit train traffic for the Eastern Powder River Basin are shown in Table R2-27. Current coal traffic data reported by the BN are shown in Table R2-25. Coal trains from the Eastern Powder River Basin in Table R2-25 appear in the change in coal traffic between Gillette, Wyoming and Edgemont, South Dakota. Based on BN projections, approximately 77% of the coal trains traveling towards South Dakota and Nebraska currently originate in the Eastern Powder River Basin. The remaining 23% come from coal mines in Sheridan County, particularly the Big Horn Mine, and from the Decker Mine in the state of Montana. All coal transported out of the Eastern Powder River Basin is now moving eastward towards market destinations shown in Table R2-27.

Community Effects

Effects of coal train traffic are already felt not only in the immediate vicinity of the mine, but also along the railroad line where train traffic has increased. Communities along the BN route feel the effects of rail traffic in a variety of ways. Traffic delays occur at railroad-highway crossings, creating an inconvenience to local residents. Essential services such as ambulance, fire, and police are also detained at railroad crossings.

The magnitude of these effects depends on the frequency of exposure, the length of the train, and the train speed (U.S. Department of Transportation 1978). Unit trains, which average about a mile in length, take 3 minutes to pass a particular point at 20 miles per hour. If the speed slows to 5 miles per hour, as it sometimes does near switchyards, it takes 12 minutes for the same length train to pass. The effect of speed at crossings is apparent from the following example: given a traffic flow of 25 unit coal trains per day, a railroad crossing is impassable for an hour and 15 minutes per day at 20 miles per hour and for 5 hours per day at 5 miles per hour.

The frequency of vehicle-train accidents at crossings increases with the frequency of trains. Although each crossing presents a unique situation, and it is therefore difficult to estimate accident rates, the following rates have been projected for a crossing protected by flashing lights. With 1,000 motor vehicles and 10 trains passing per day, an accident would be expected once every 100 years. With the same vehicle traffic and 25 trains per day, an accident would be expected three times every 100 years. With 50 trains per day, the expected rate would increase to six every 100 years (personal communication, Interstate Commerce Commission 1978).

Air pollution from increased rail traffic is not yet considered a problem in the state of Wyoming, since breezes rapidly dissipate exhaust fumes and coal dust (personal communication, Chuck Collins, Wyoming Department of Environmental Quality 1978).

Even though the intensity of noise levels does not increase as additional train traffic occurs, the frequency of exposure causes more irritation to local residents, particularly if the railroad tracks are located near residential areas. The U.S. Environmental Protection Agency has set 55 L_{dn} (decibles weighted on a day-night basis) as a

TABLE R2-25

ESTIMATED AVERAGE DAILY TRAFFIC IN REGION
-1978-

	Eastbound Trains		Westbound Trains		
	Regular Freight	Coal*	Regular Freight	Coal*	Total
Sheridan to Gillette, Wyoming	2	2.5	2	2.5	9.0
Gillette to Donkey Creek	2	3.25	2	3.25	10.5
Donkey Creek to Edgemont, S.D.	3	10.67	3	10.67	27.34
Edgemont to Alliance, Nebraska	2	10.67	2	10.67	25.34
Alliance to Grand Island**	2	7.11	2	7.11	18.22
Grand Island to Lincoln	6	7.11	5	7.11	25.22
Alliance to Northport**	3	3.56	3	3.56	13.12

Source: Personal communication Gerald Davies, Assistant Vice President of Coal, Burlington Northern Inc., April 24, 1978.

* Increase due to Eastern Powder River Basin coal amounts to 8.2 trains eastbound and 8.2 trains westbound.
** Traffic moves both south and east on Burlington Northern tracks lines out of Alliance, Nebraska.

TABLE R2-26

REVENUE FREIGHT ORIGINATING ON BURLINGTON NORTHERN RAILROAD
(1973-1975-1977)

Year	Principal Commodities		Number of Tons (2,000 pounds)	Percent of Total
1977	Coal		17,370,428	88
	Noncoal:		2,266,530	12
	Stone, Clay, and Glass, Products	1,177,887		
	Petroleum and Coal Products	406,822		
	Nonmetallic Minerals, except Fuels	290,717		
	Farm Products	128,533		
	Other	262,571		
	Subtotal:	2,266,530		
	Total:		19,636,958	100
1975	Coal		4,923,208	69
	Noncoal:		2,219,021	31
	Stone, Clay, and Glass Products	1,175,055		
	Petroleum and Coal Products	356,536		
	Nonmetallic Minerals, except Fuels	300,933		
	Farm Products	180,802		
	Other	205,695		
	Subtotal:	2,291,021		
	Total:		7,142,229	100
1973	Coal		1,711,452	40
	Noncoal:		2,519,087	60
	Stone, Clay, and Glass Products	1,186,343		
	Petroleum and Coal Products	446,333		
	Nonmetallic Minerals, except Fuels	255,359		
	Farm Products	391,457		
	Other	239,595		
	Subtotal:	2,519,087		
	Total:		4,230,539	100

Source: Public Service Commission, Cheyenne, Wyoming, April 1978.

TABLE R2-27

ESTIMATED PRODUCTION LEVELS OF COAL FROM EXISTING MINES IN 1978

Existing Mines	Number of Unit Trains for 1978*	Market Destination**
Wyodak	0	Mine Mouth (Wyodak)
Dave Johnston	0	Mine Mouth (Dave Johnston Power Plant)
Belle Ayr	1,650	Colorado, Texas, Indiana, Kansas, Missouri, Iowa
Cordero	500	Texas
Rawhide	300	Indiana, Nebraska
Black Thunder	350	Nebraska, Oklahoma, Texas
Jacobs Ranch	200	Arkansas, Louisiana, Oklahoma
Eagle Butte	120	Unknown
Kerr-McGee #16***	---	Unknown
	3,120	

Daily average = 3,120 trains per year ÷ 365 days = 8.5 trains per day eastbound (loaded)
8.5 trains per day westbound (empty)

Source: Based on conversations with Gary Glass, Wyoming Geological Survey, Dale Hoffman, Department of Economic Planning and Development, Wyoming State Government, and Don Warfield, Community Relations Representative, AMAX Coal Co., April 1978.

* The length of a unit coal train currently varies between 80 and 90 cars, however, the available train length is expected to increase to 100 to 110 coal cars. Current and projected traffic estimates assume an average train length of 100 cars with five diesel units.

** Based on contracts reported in Western Oil Reporter, February 1978.

*** Not operational in April 1978. Production may begin later this year.

long-term exterior noise level limit for the protection of public health and welfare. A 70 L_{dn} level is considered by some researchers as the threshold of noise causing hearing loss. Assuming train speeds of 20 miles per hour, that trains pass at uniform intervals over a 24-hour clock, and that the track is level, the 70 L_{dn} level would likely occur only within the railroad right-of-way, but the 55 L_{dn} level would occur beyond the right-of-way, e.g., ¼ mile with 50 trains passing per day (personal communication, Interstate Commerce Commission 1978).

The BN track and principal communities affected by rail traffic locally in northeastern Wyoming are shown in Figure R2-39. Similar information is presented in Figure R2-40 for out-of-state communities affected by the movement of the region's coal. Since coal traffic on the BN branches out to various market areas in Lincoln, that community is the most easterly point reviewed.

The major effects cited by local officials are summarized below.

Sheridan. Five coal trains and four regular freight trains pass through Sheridan daily. Currently, an at-grade crossing at Fifth Street is the most serious problem (*The Sheridan Press*, February 9, 1978). Automobiles and pedestrians are often delayed for 10 minutes at a time. The location of a switchyard near the center of Sheridan contributes to traffic delays, because trains reduce their speed as they approach the switchyard. This lengthens the time it takes to pass by a crossing. A railroad crossing study conducted by the State Highway Department in 1977 identified the Fifth Street crossing as needing a grade separation, but funds have not yet been appropriated for this (personal communication, John Hollingsworth, Sheridan County Planner 1978).

Gillette. Although coal and regular freight trains currently amount to only eight per day, serious problems were reported. Automobile and pedestrian traffic is often blocked downtown while train crews change in Gillette.

Another result of the train traffic is the isolation of the north section of Gillette from the rest of the community whenever a train passes by. Emergency services have difficulty reaching residents located north of the railroad tracks (*Casper Star Tribune*, March 27, 1978). The only grade-separated crossing available, an underpass, is already overloaded with traffic converging on it from three other highways lacking grade separations. Construction to expand the underpass to four lanes is expected to begin some time in 1980 and be completed about a year later (personal communication, John Lane, Wyoming State Highway Department 1978).

Newcastle. Currently, train traffic in this community amounts to 27 trains per day. All these trains pass through the center of town, affecting both residential and commercial districts. Noise from the trains, particularly whistles blowing in the early morning hours, is annoying to residents. At-grade railroad crossings are also a problem in Newcastle. Although an overpass and a centralized traffic control system were recently completed to relieve some of the traffic congestion, access to the overpass can be inconvenient. Often, residents have a choice of taking a 10-minute detour via the grade separation or waiting 10 minutes at a railroad crossing for the train to pass (personal communication, Abbie Birmingham, Tri-County Planner 1978).

Alliance, Nebraska. Train traffic currently amounts to 25 trains per day. Although three grade separations are available for vehicle movement, transit problems are still occurring. An at-grade railroad crossing at West 10th Street, a major farm to market road, was cited as the most serious problem. Also, the presence of a switchyard adds to the delays due to train traffic since trains reduce speed considerably as they pass near the yard.

Alliance has also experienced problems due to the renovation of the BN switch yard to more efficiently accommodate coal trains. Population increases related to the construction work have placed a heavy burden on housing and utility services (personal communication, R.A. Placek, Alliance City Manager 1978).

Grand Island. The eastern section of Grand Island is already noticeably isolated by rail traffic. Due to the location of the railroad tracks in relation to residential area, people living in the eastern section of Grand Island have limited access to emergency services located on the west side of town.

The Union Pacific (UP) and BN main line tracks intersect in downtown Grand Island, creating heavy train traffic. Trains average 22 per day on the BN line and 30 per day on the UP line (personal communication, Dave Wheeler, Union Pacific Railroad Company 1978). Serious automobile traffic delays are occurring at some of the BN at-grade railroad crossings. These delays are expected to shorten after (1) BN installs radio communications equipment at the UP interlocking tower that will allow direct communication with BN trains, and (2) the 10-mile-per-hour speed limit is lifted on the UP crossing of the BN track as a result of the installation of a new crossing diamond. Additionally, access to an airport located in the northern section of town is sometimes a problem (personal communication, Earl Ahlschwide, Grand Island City Manager 1978).

Lincoln. In a report of the Coal Transportation Task Force, "Transporting the Nation's Coal—A Preliminary Assessment,"Lincoln, Nebraska was referred to as the "coal chute of America"(U.S. Department of Transportation 1978). Lines from five railroad companies converge in the center of Lincoln: the BN, Chicago and North Western, Missouri Pacific, UP, and the Chicago, Rock Island, and Pacific. Four of these railroads have depots located within four blocks of each other. The fifth, the Rock Island, has a train depot about a mile from the other railroad stations. Unit coal trains on the BN originating in the Eastern Powder River Basin affect this town, but the density of other train volume makes it difficult to isolate these effects.

The National Transportation Safety District is currently implementing the second phase of a four-phase program calling for relocation and consolidation of tracks in Lincoln (personal communication, Lester Fletcher, Public Services Commission 1978). This program is expected to relieve many of the problems currently being experienced in Lincoln.

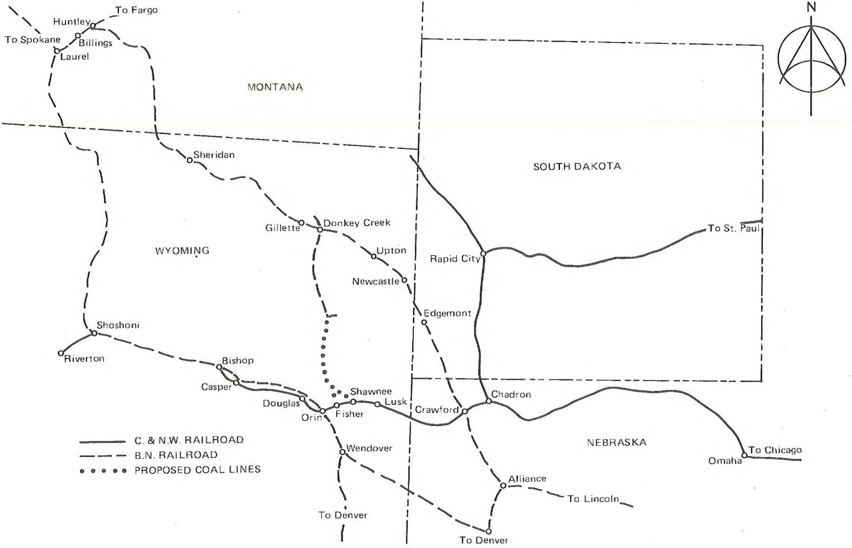


Figure R2-39
RAILROAD LINES SERVING EASTERN POWDER RIVER BASIN

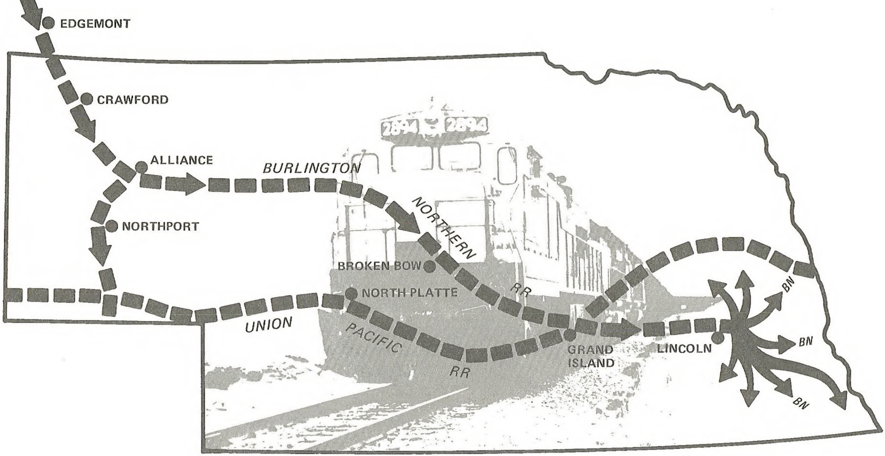


Figure R2-40
CURRENT ROUTING OF POWDER RIVER BASIN COAL ON THE BURLINGTON NORTHERN THROUGH SOUTH DAKOTA AND NEBRASKA

Highways

The major federal, state, and county highway transportation routes of the eight northeastern counties of Wyoming are shown in Map 11, Appendix A. Two four-lane, divided, controlled-access interstates traverse this section. Interstate 25 runs north and south between Sheridan and Cheyenne, and Interstate 90 runs east and west between Sheridan and Rapid City, South Dakota. (A portion of Interstate 25 remains uncompleted between Casper and Buffalo.) The area is served, in addition to Interstates 25 and 90, by a system of federal and state highways, and county, private, Bureau of Land Management, and Forest Service roads.

Figure R2-41, a traffic flow chart derived from Wyoming State Highway Department information, illustrates the volume of traffic over major roads in this eight-county region in 1975.

State Highways 59 and 387 are inadequate to handle present traffic flows. Highway 59 is the major state highway in Campbell and Converse counties, running from Douglas through Reno Junction (near the new community of Wright on State Highway 387) to Gillette and north to Broadus, Montana. Portions are narrow, winding, and rough; the highway lacks truck lanes on steep grades at present. State Highway 387 leaves U.S. Highway 87 at Midwest and goes east to Reno Junction where it meets State Highway 59. At present, this road is poor due to curves and narrowness, although portions have been improved between Midwest and the junction with State Highway 50.

Both Gillette and Campbell County have been unable to maintain local streets and roads to acceptable standards as regional energy development and the resulting rapid population growth has occurred. Of those responding to the 1977 Citizens' Policy Survey in Gillette, 88% of those residing in unincorporated portions of the county and 98% of those residing in Gillette felt that road and street maintenance needed to be improved (City of Gillette/Campbell County Department of Planning and Development). Similarly, 79% and 82%, respectively, of county and city residents felt that traffic control needed improvement.

Campbell County residents voted in favor of an optional 1% increase in the county sales tax on November 2, 1976. This increase must be renewed every 2 years. The tax is expected to generate about $2.5 million annually, with 55% going to Gillette and 45% to Campbell County. A consultant completed a street inventory for the city during April 1977, and then during July 1977, selected priority improvements costing $3 million to be done by the city. The city will spend approximately $1.5 million, plus an additional $1.5 million of a matching funds grant from the Wyoming State Farm Loan Board, for street improvements during 1978—this amounts to about $430 per household. The county appropriated $2.2 million for county road work during fiscal year 1977-78, up 57% from the previous fiscal year.

Air Service

Seven commercial airports are within the eight northeastern counties of Wyoming. They are at Buffalo, Casper, Douglas, Gillette, Lusk, Newcastle, and Sheridan (Table R2-28).

The eight counties are served by two national carriers, Frontier and Western airlines, at Casper and/or Sheridan airports (Figure R2-42). In addition, Wyoming Airlines Ltd. provides scheduled service between Denver, Casper, and Gillette. Casper Air Service and Wyoming Central Aero-Ways provide charter service from Casper. Various energy companies and individuals operate private planes and jets out of both Casper and Gillette.

Because of the low population base in Wyoming, as well as its location outside of the national air corridors, commercial service in Wyoming is provided primarily as feeder routes to either Salt Lake City, Denver, or Minneapolis.

As growth and development increase in Wyoming, so will the use of its airways and air service. According to figures supplied by the Federal Energy Administration, the use of aviation fuel in Wyoming (a good indicator of the amount of air travel) increased approximately 30% from May 1975 to May 1976 and increased another 30% from May 1976 to May 1977 (personal communication 1977).

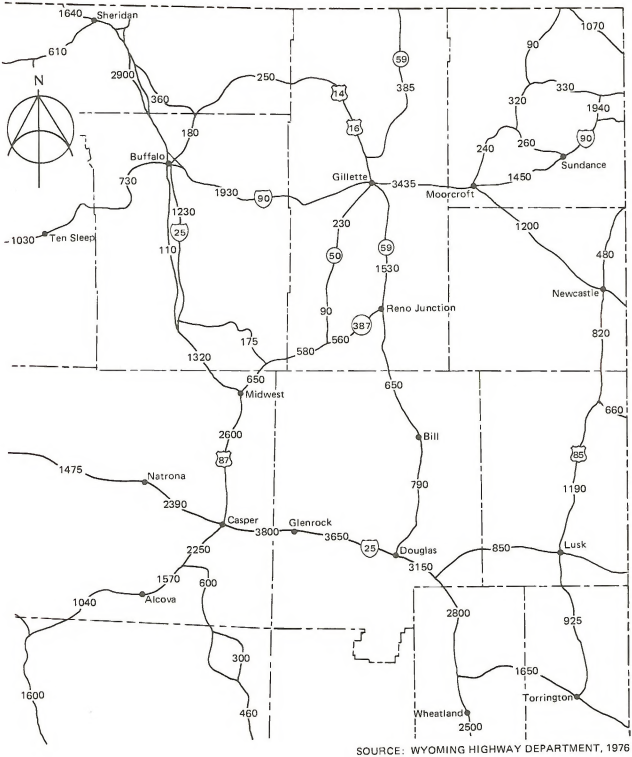
The Gillette-Campbell County Airport is the only airport in the Eastern Powder River Basin served by scheduled commercial service; three commuter airlines provide flights to Denver, Sheridan, Casper, Cheyenne, and Billings. The airport is also used by several charter airlines, and corporate and private aircraft.

In order to prepare for increased traffic, the runway has been patched and lengthened, a control tower has been added, and a new terminal building has been built.

Deficiencies in the runways at Gillette currently limit the size of aircraft that may land to 12,000 pounds, which precludes service by many types of commercial aircraft. Also, the location of the airport may prevent the expansion of facilities. The Department of Transportation granted $42,000 to the airport board to begin drafting an airport master plan. The city and county must each provide $4,200 in matching funds. Depending on the eventual findings of the study, the airport may have to be relocated. Two to 5 years will probably be required to upgrade the existing facilities, and the cost is unknown.

Bus Lines

The eight northeastern counties of Wyoming are served by two commercial bus lines: Continental Trailways and Central Wyoming Transportation Company. Continental Trailways operates north on Interstates 25 and 90 from Casper to Midwest, Buffalo, Sheridan, and Billings; north on Interstates 25 and 90 from Casper to Gillette via Buffalo; and south on Interstate 25 from Casper to Douglas and Cheyenne (personal communication, Ed Shilling 1977). Central Wyoming Transportation



SOURCE: WYOMING HIGHWAY DEPARTMENT, 1976

Figure R2-41
AVERAGE DAILY TRAFFIC (24 HOURS) IN 1975
EASTERN POWDER RIVER BASIN

TABLE R2-28

MAJOR AIR SERVICE IN EIGHT NORTHEASTERN COUNTIES OF WYOMING (1977)

County/Municipality	Principal Airport	Runway Length	Runway Lights	Service
Campbell/Gillette	Gillette Municipal	5,500 ft.*	yes	Scheduled commercial
Converse/Douglas	Converse County	5,000 ft.	yes	Charter and private only
Johnson/Buffalo	Buffalo Municipal	5,000 ft.	yes	Charter and private only
Natrona/Casper	Natrona County International	10,600 ft.	yes	Scheduled commercial**
Nibrara/Lusk	Lusk	4,790 ft.	yes	Charter and private only
Sheridan/Sheridan	Sheridan County	6,650 ft. 5,039 ft.	yes	Scheduled commercial**
Weston/Newcastle	Newcastle	4,700 ft.	yes	Charter and private only

Source: Wyoming State Department of Economic Planning and Development.

* At present, the Gillette runway has been shortened by 1,300 feet because of ground upheavals.
** Including Frontier and/or Western airlines.

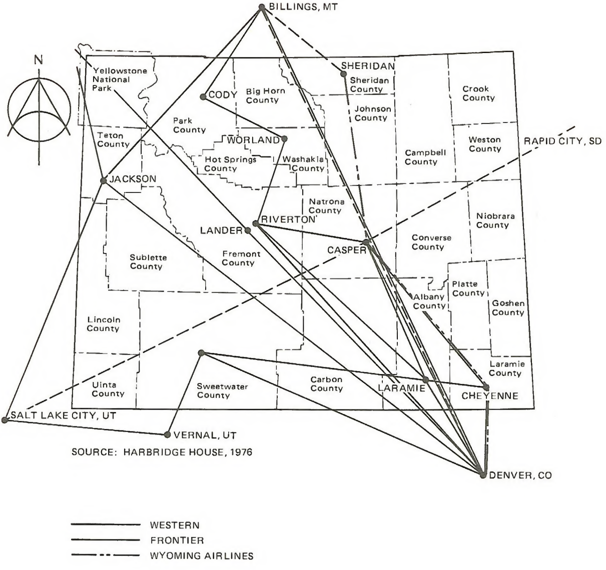


Figure R2-42
MAJOR AIRLINE ROUTES IN WYOMING

Company operates from Casper to Rawlins via State Highways 220 and 287.

Pipelines

Major oil and natural gas pipelines have been delineated in Figure R2-43. There are an estimated 999 miles of major pipelines presently within Campbell and Converse counties. The pipelines shown are used primarily in the transportation of petroleum products from oil and gas fields. The petroleum products shipped are crude oil, natural gas, gasoline, propane, and butane.

Electric Transmission Lines

Major electric transmission lines have been delineated in Figure R2-44. There are 370 miles of major power lines (69 kilovolt and larger) within Campbell and Converse counties.

Electrical service is furnished to the southern portion of the region by Pacific Power and Light Company. Their main source of power comes from the Dave Johnston Plant near Glenrock, which has a four-unit generating capacity of 750 megawatts. Electrical service is provided to the northern portion region by the Black Hills Power and Light Company and Pacific Power and Light Company; power is generated at the Wyodak Plant near Gillette.

Telephone

Converse and Campbell counties are serviced by Mountain Bell Telephone Company. The approximate number of telephones as of December 1976, was 3,412 in Converse County and 6,554 in Campbell County. In 1976, the company spent $44 million on new construction in Wyoming, and they plan to spend $50 million for growth and change in 1977 (personal communication, R.G. Peterson 1977).

In the spring of 1976, Mountain Bell installed a new facility in Gillette, making it the most modern system in the state. This new system, besides additional lines, includes services such as solid-state memory units, automatic data and billing, call waiting, call forwarding, speed calls, conference calls, and direct dialing for collect and credit calls.

Within the eight northeastern counties of Wyoming, as of July 1977, Mountain Bell had only one underground cable running from Casper to Powder River, and one overhead toll line running from Glendo to Casper to Midwest to Buffalo.

SOCIOECONOMIC CONDITIONS

Introduction

Since many of the economic impacts of regional development in the Eastern Powder River Basin would affect neighboring counties, the description of socioeconomic conditions covers an eight-county region in northeast Wyoming: Campbell and Converse counties, as well as Crook, Johnson, Natrona, Niobrara, Sheridan, and Weston counties.

Historic Overview

Northeastern Wyoming has undergone a succession of economic boon and bust cycles since 1878. From open range grazing last century, to homestead land acquisition and farming after the turn of the century, to petroleum development during the 1950s and '60s, the region has periodically benefitted from short-term booms that did not result in regional long-term population and economic growth. The result has been a low rate of population growth and depressed economic conditions punctuated by booms which made a few rich and left wakes of social disruption. Long-term planned growth has not been a factor in the region's past history.

Overall population growth for the eight northeastern counties of Wyoming has been extremely slow since at least 1940. The exceptions to this are the energy development booms that have caused rapid but temporary population increases in some relatively limited areas. Most notable of these economic booms were the oil developments that occurred in Weston County in the 1940s and 1950s and in Campbell County, particularly in the late 1960s. These booms have caused rather dramatic population impacts in local areas but have had relatively small overall impact. For example, during the 1960-1970 period, five of the eight counties in northeastern Wyoming experienced population decreases and seven of the eight counties (with Campbell County the one exception) experienced net out-migration.

Traditionally, northeastern Wyoming has been ranching country. Many of the ranches located in this area were among the last homesteaded in the United States, and for much of the last century, ranching has been the principle way of life for the people of the area (Massey 1977). The small towns that dot the landscape were established to meet the needs of the ranchers of the vast geographic areas that surround them. Like the thousands of other small, rural, agriculture-dominated towns that characterize this area of the country, the towns of northeastern Wyoming were friendly and intimate, the pace was easy, life was predictable, and the problems were personal (ibid.).

Sociocultural Profile

Introduction

Other sections of this report describe what could be called the objective quality of life of the inhabitants of

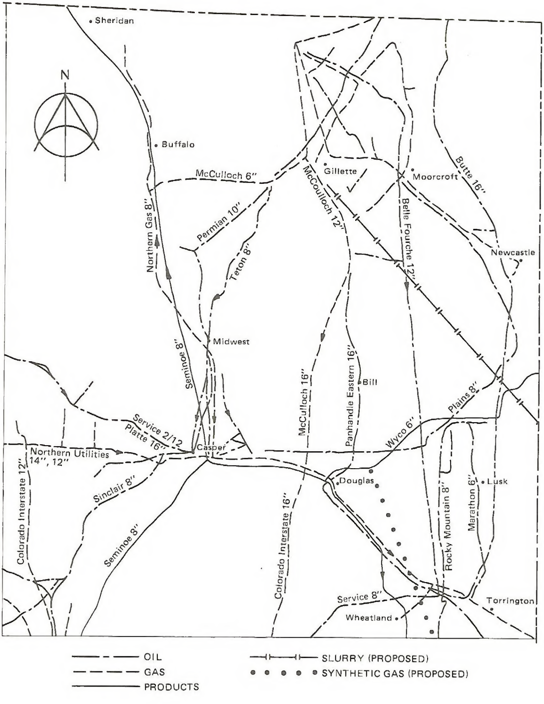
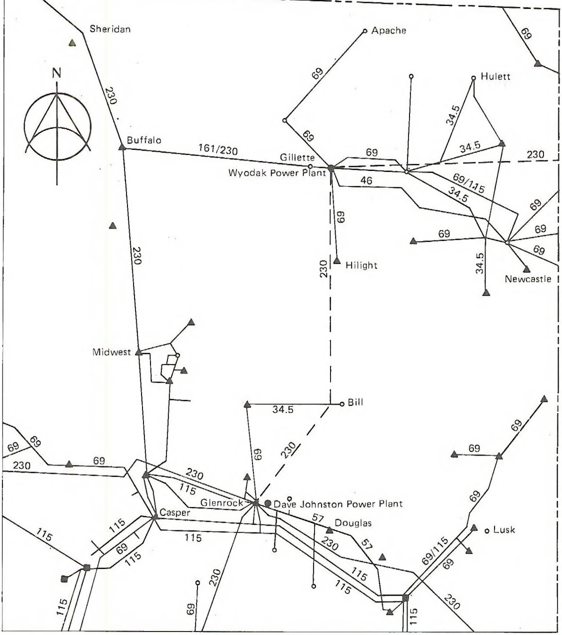


Figure R2-43
MAJOR PIPELINES IN THE EIGHT NORTHEASTERN COUNTIES OF WYOMING



SUBSTATION
HYDROELECTRIC GENERATING STATION
EXISTING TRANSMISSION LINES
PROPOSED TRANSMISSION LINES

Figure R2-44

MAJOR TRANSMISSION LINES IN THE EIGHT NORTHEASTERN COUNTIES OF WYOMING

northeastern Wyoming. These objective indicators of life quality include such things as local crime rates, health statistics, educational opportunities, opportunities for recreation, and availability and quality of local housing. In this section, however, we will approach the problem from a more subjective perspective by assessing the attitudes and values, lifestyles, and psychological environment of northeastern Wyoming. While the regional developments being assessed in this study have potential implications for the objective quality of life indicators (for example, the mean income of local residents may increase, crime rates may go up as a function of rapid population growth, and so on), it also has potentially important implications for subjective values. It is these latter values that will be the focus of this part of the document.

In many impact studies, "social impact"has come to mean merely the impact of people on service agencies (Freudenburgh 1976). While this certainly is important, it has virtually nothing to do with how human beings, whether they be old-timers or newcomers to the area, are reacting to the changes being wrought. What Freudenburgh (ibid.) calls the "less tangible"considerations—things like community social integration and subjective reactions of the population to the changes that are occurring—are at least equally important in assessing the social implications of energy development projects.

Information on baseline attitudes and values in northeastern Wyoming is taken from a variety of secondary sources. Specifically, over the last 3 or 4 years, several studies have been conducted in the area that have included attitudinal surveys and other information obtained through interviews and questionnaires. Each survey contains data relevant to the description of the existing social environment of the area. However, the limitations of these available sources should also be noted. None of the surveys is areawide in its scope. Rather, each concentrates on one or more communities and/or counties. Second, none of the studies was conducted with a focus on the range of developments that are being assessed in this environmental statement. Despite these limitations, these prior studies provide data which allow the development of a general statement of public attitudes and values in northeastern Wyoming.

In June 1977, a citizens' policy survey was conducted by the City of Gillette/Campbell County Department of Planning and Development. The survey was repeated in August 1978, and revealed substantially the same major concerns. The survey findings provide the most current information on local attitudes and values. Some of the results of the studies of attitudes in Buffalo and Douglas (Uhlmann et al. 1976) and Campbell County (Paanenen et al. 1976) are also used in this report.

Attitudes and Values

Although wide publicity has been given to some of the negative effects of boom towns, the one thing that stands out most clearly in all the studies is that there is great variety in the attitudes of the residents of such impacted areas, and easy generalization should be avoided.

Traditional agrarian attitudes and values common in northeastern Wyoming are being challenged by characteristics (attitudes and values) related to boom-town conditions and by the process of industrialization. The potential for conflicts between the two sets of attitudes and values is great.

Community Services. Satisfaction with selected community services and facilities in Buffalo and Douglas (1975), are shown in Table R2-29. The only major area of dissatisfaction delineated in Table R2-29 for Buffalo is its streets and roads (71% dissatisfied), and since 1975, efforts have been made to improve that problem.

In Douglas, substantial percentages of dissatisfaction are expressed in several areas: water supply (74%), mental health services (65%), and streets and roads (52%). Also, a plurality of respondents expressed dissatisfaction with city planning.

Land Use. Local government and the population of northeastern Wyoming have been historically opposed to any form of land use planning. However, there is concern about future growth of urban areas. Campbell, Converse, and Sheridan counties have prepared or are preparing needs surveys, interim concept plans, and general comprehensive plans. These actions indicate some support in the area for evaluation of land use and possible controls.

There are some indications of local attitudes toward specific land uses. For example, a major concern appears to be preservation of natural resources. In Campbell County, 44% of the respondents to an attitudes survey expressed concern about damage to the environment; while only 15% were not concerned (Blevins et al. 1974). The City of Gillette/Campbell County Citizens' Policy Survey (1977) found that 79% of the respondents agreed with the statement that zoning can protect property values and properly guide community development, if enforced.

Government and Its Entities. The City of Gillette/Campbell County 1977 Citizens' Policy Survey indicates attitudes concerning various city and county services. Services provided in Campbell County which received the lowest ratings include county road maintenance and traffic control. The services or improvements in the city of Gillette which received the lowest ratings by its residents include water quality, street maintenance, and storm drainage. Medical services received the lowest rating of those services provided to both city and county residents with only 5.8% of the respondents indicating that they are presently adequate.

About the statement that city government is doing a good job in solving problems associated with rapid growth, 22% of the respondents said that they either agree or strongly agree and 56.7% indicated that they disagreed or strongly disagreed. (In 1978, these percentages were 34.5 and 41.8, respectively.) A similar statement that county government is doing a good job of solving problems associated with rapid growth yielded a 27.9% rate agreement and 43.5% rate of disagreement. (In 1978, these percentages were 35.8 and 35.8, respectively.) Public dissatisfaction with local government

TABLE R2-29
SATISFACTION WITH SELECTED COMMUNITY SERVICES AND FACILITIES, BUFFALO AND DOUGLAS, 1975
(Percent of Total)

	Buffalo				Douglas			
	Satis-fied*	Neutral	Dissatis-fied**	(N)	Satis-fied*	Neutral	Dissatis-fied**	(N)
Law Enforcement	69	10	21	(242)	89	2	9	(238)
Fire Protection	96	3	1	(224)	98	1	1	(240)
Water Supply	89	4	7	(253)	20	7	74	(257)
Sewer Service	94	2	3	(252)	60	8	32	(256)
Garbage Collection	84	7	9	(248)	66	6	28	(252)
Telephone Service	94	2	4	(245)	89	2	9	(247)
Streets, Roads	19	10	71	(254)	39	9	52	(255)
City Planning	67	14	19	(138)	36	21	43	(201)
Elem. School	88	6	7	(200)	79	7	13	(68)
High School	88	5	7	(193)	81	6	13	(67)
Day Care	87	6	7	(117)	91	8	2	(65)
Present Dwelling	87	5	8	(254)	91	5	4	(257)
Medical Services	76	5	19	(242)	70	7	23	(241)
Mental Health Services	94	3	3	(115)	20	15	65	(79)
Indoor & Outdoor Sport Facilities	68	8	25	(224)	59	21	20	(212)
Amusements	67	7	25	(224)	42	17	40	(229)

TABLE R2-29
(cont'd)
SATISFACTION WITH SELECTED COMMUNITY SERVICES AND FACILITIES, BUFFALO AND DOUGLAS, 1975
(Percent of Total)

	Buffalo				Douglas			
	Satis-fied*	Neutral	Dissatis-fied**	(N)	Satis-fied*	Neutral	Dissatis-fied**	(N)
Educational & Cultural Program	81	4	14	(202)	50	23	27	(202)
Community Recreation Program	80	5	15	(192)	63	19	17	(197)
Social Services & Welfare Program	73	10	17	(120)	63	18	18	(49)
Programs for Senior Citizens	69	10	21	(162)	94	3	3	(150)
Shopping Facilities	62	7	31	(253)	64	11	25	(252)
City Government	72	15	13	(219)	48	16	36	(237)
Organized Clubs & Activities	93	4	4	(198)	88	8	4	(229)
Mail Service	90	6	4	(252)	95	2	2	(255)
Religious Services & Churches	99	1	0	(242)	98	1	1	(233)
Household Services	73	11	17	(227)	75	4	21	(223)

Note: Figures in this table are computed from the frequency distributions calculated from the percentage tables in Uhlmann et al. 1976. "Don't Know" responses have been deleted from the percentage bases. In every case, the number of "Don't Know" responses may be computed by subtracting the (N) reported from 254.

* Including the responses, "Very Satisfied" and "Satisfied."

** Including the responses, "Dissatisfied" and "Very Dissatisfied."

probably is related to the problems created by rapid population growth and boom-town conditions.

Area Development and Growth. There seems to be general ambivalence towards growth and development for the county. The majority of the people responding to the 1977 City of Gillette/Campbell County Citizens' Policy Survey felt that rapid population growth is not good for the county. But on the other hand, 75% felt that industrial development is good for the county. Apparently, population growth is perceived as a negative aspect of industrialization.

There are also indications that most residents feel growth and development is inevitable. The ambivalence arises out of a concern for the consequences of development. The residents like their towns and the friendly atmosphere, an atmosphere directed toward the old-time residents, which need not be extended to outsiders who are often viewed as fair game for exploitation. The long-time residents generally worry that growth may destroy their small-town atmosphere (Thompson et al. 1975).

Residents' opinions about the possible beneficial consequences of continued development are summarized in Table R2-30. Regardless of the research site, the prevailing estimate of the general consequences of development is positive. It should be noted the questions on Table R2-30 deal only with economic, and not social, consequences of energy development.

The findings from these surveys may be summarized as follows. Those who define the projected development as *not* economically beneficial are in the minority. There is a substantial minority, somewhere between 17% and 25% of the population, who are undecided or neutral about the possible benefits of development. The largest group feels the economic consequences of development will be ultimately beneficial; however, it seems that the economic benefits defined by these people presuppose appropriate controls to ensure protection of the environment.

Paanenen and others (1976) presented tables showing the distribution of Campbell County respondents' attitudes towards strip mining, and the following discussion draws upon those percentage tables. While the Campbell County respondents generally agreed that development would bring more money, jobs, and services, they were unsure about its effects on friendship and community solidarity, being almost exactly divided (43% versus 40%) on whether it would mean a decline in these valued community characteristics. Almost half (49%) were in agreement that local autonomy would decline. As for the church, most indicated that they did not think that it would become less important.

Note that with respect to these items about potential community change, the respondents in Gillette and Campbell County were not asked if they were willing to make the trade-offs between increases in taxes, jobs, and local income and declining personal autonomy and the possibility of declining community solidarity. Instead they simply agreed, yes, tax revenues, available jobs, and local incomes would increase, possibly friendship ties would decrease, local autonomy would decrease, and no, the church would not wither away. The essential final step—were they willing to make such trade-offs—was not included in the survey, although there were some questions of this form with respect to the physical environment. So the analyst can only guess about which trade-offs would be acceptable to residents at this point.

A majority of the respondents agreed that development of strip mines would be good for Wyoming. Only slightly over a third (36%) were willing to state that the coal development was one of the best things that ever happened, but 50% agreed that in the long run they would be better off (25% were neutral about this, and only 25% disagreed), and 60% agreed that Wyoming needed the proposed mining (only 21% disagreed with the fact of Wyoming's need).

While residents agreed that coal development would be a good thing and was needed, they were not willing to sacrifice the environment to save jobs. Only one out of four respondents agreed that industry should be allowed to keep polluting if stopping operations would put people out of work, and only 23% agreed that the right to a clean environment was less important than the right to employment. The respondents recognize the need for the development, but at the same time a plurality (between 43% and 46%) would stop production rather than sacrifice the environment.

As for other perceived negative effects of development, almost half (47%) agreed that there would be some negative effects upon crops and grazing. At the same time, 50% did not feel that the strip-mining operations would use water needed elsewhere.

Finally, there was more support for a "proceed with due caution"approach than for any other item in the entire series: 77% agreed that development of the strip mines should proceed "only when we have developed adequate standards and enforcement procedures"

Variations in attitude toward development by occupation are also of some interest. Over the past decade, a large sociological literature has been developed which suggests that attitudes toward environmental preservation, conversely, toward exploitation of resources, are tied closely to one's occupation, income, and educational background. Specifically, this literature argues that the environmental movement is largely an upper middle class movement—that persons with higher educations, more prestigious occupations, and higher incomes are likely to express more favorable attitudes toward environmental preservation and more negative attitudes toward resource exploitation. However, an early study by French (1974—data actually collected in 1970) found that upper middle class persons in Johnson County, Wyoming were not disproportionately preservationist in their outlook. Further, French observed that ranchers (generally in the upper income brackets) were more favorable toward strip mining than any other occupational group. Other studies have strongly contradicted French's findings on the attitudes of ranchers. For example, the survey findings of Blevins and others (1974) and comprehensive ethnographic findings of Gold (1974a, 1974b, 1974c, 1976) and of Freudenburgh (1976) show that persons in agriculture are more concerned about development than any other occupational group. Freudenburgh argues that the

TABLE R2-30

ATTITUDES ABOUT THE BENEFITS OF ENERGY DEVELOPMENT AMONG RESPONDENTS IN CAMPBELL COUNTY (1974), BUFFALO (1975), AND DOUGLAS (1975)

Item and Location	Percent of Total Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Campbell County (N=219)					
There will be more tax money available for better schools.	17	44	18	15	6
There will be more jobs available so that young people will be able to remain here rather than having to move away.	21	58	13	8	1
We will have better community services such as improved health care.	10	33	26	25	7
Incomes for local people will improve.	10	57	15	13	5
General "Potential Development will be beneficial" composite item*	14	48	18	15	5
Buffalo (Old-timer subsample, N=160)					
Potential economic development will be beneficial	1	42	26**	29	2
Potential development will be beneficial to me personally	0	32	7**	59	1
Douglas (Old-timer subsample, N=166)					
Potential economic development will be beneficial	8	57	19**	15	1
Potential development will be beneficial to me personally	13	27	11**	34	16

Source: Paanenen et al. 1976, Uhlmann et al. 1976.

* This composite item is a summary of the above four items, weighed equally, and is intended to provide a general indicator for comparison to the responses for Buffalo and Douglas.

** "Don't Know" responses are included with "Neutral" responses. For Buffalo the proportions "Don't Know" on these items were 5% for each item; for Douglas the corresponding figures were 4% and 1%.

early date of the French survey may have been important in its unusual findings, as might other conditions, including the fact that the company collecting coal holdings in the Johnson County area had been promising ranchers an increased supply of irrigation water.

French's other major finding (that upper middle class persons in Johnson County were not disproportionately perservationist in their orientation) has received general support from Blevins and others (1974) in their survey of Campbell County residents. These latter researchers found that white collar persons were less willing to impose strip-mining regulations than any other occupational group included in their survey. They argue that white collar persons in the area—bankers, businessmen, etc.—may perceive themselves as having more to gain financially from mining and other related energy development in the area than any other group. This would help to account for a pro-development orientation.

Evidence accumulated by Blevins and others (1974) also suggests that residents in northeastern Wyoming (particularly in Campbell County) show somewhat less concern over development than do their neighbors in southeastern Montana. Gold (1974c) has attributed this difference to what he refers to as a weaker attachment to the land and to neighbors in Wyoming, which, he feels results from larger ranch size and more frequent corporate ownership.

One aspect of community solidarity is the perception of personal influence, the notion that oneself or one's groups have an input in the decisions that are made. As shown in Table R2-31, perceptions of loss of control as development occurs are somewhat more frequent in Campbell County than in Buffalo or Douglas. The figures in the table also suggest a clear gradient in perceptions that newcomers will upset the established order, with Campbell County residents most convinced that development will mean loss of local influence, followed by Buffalo old-timers and then Douglas old-timers (49%, 39%, and 31%, respectively). In summary, there is a great deal of ambiguity or neutrality concerning this matter in Douglas, while the residents of Campbell County and Buffalo seem to have firmer opinions on the matter.

Old-timers and Newcomers. No areawide indicators of attitudes toward outside influences and people have been encountered. One study from western Wyoming provides some information which is probably relevant to eastern Wyoming, especially the boom-town areas. A survey of Rock Springs residents indicates some attitudes toward outsiders or newcomers (Old West Regional Commission 1975).

First, the results indicate virtually no nonwork contacts between long-term residents and newcomers. Second, newcomers are viewed as transients interested in "entertainment,"with a greater tendency to engage in criminal and other deviant acts. This indicates how long term residents of a community may per-ceive the people moving in, and how polarization based upon misunderstandings within a community can develop. Although the criticisms are moderated by the recognition that the undesirables are a minority, outsiders are still often characterized negatively by the residents of rural communities. The people who receive such labels are usually involved in activities such as construction or new mining which competes with the current agricultural life-style. Others are labeled negatively because they have been given better jobs or opportunities than the local residents.

Summary. Conflicts in northeastern Wyoming exist between (1) traditional rural agrarian attitudes and values, and the new urban industrial attitudes and values, and (2) the individual's personal freedoms, values, and attitudes, and the needs, values, and attitudes of the mass society. Area residents generally seem to want the benefits that mining and development can bring, but they do not want the associated loss of life-style. This means that the citizenry must, and generally does, recognize that local problems must be dealt with through planning and public participation.

Life-Styles

Cultural Diversity. In the past, all northeastern Wyoming communities have shared a rural agrarian way of life. Cultural diversity is currently being created in eastern Wyoming by mineral development, industrialization, and a growing tourism industry. This diversity is particularly evident in the boom-town atmosphere of Gillette. Boom towns, such as Gillette, tend to be characterized by few friendships, religious ties, or social bonds between newcomers and long-time residents. In addition to these problems, newcomers are more likely to be dissatisfied with local services and facilities than are established residents.

Old-timers and Newcomers. Northeastern Wyoming, and especially Campbell and Converse county residents, can be separated into two basic residency groups: the old-timers that have resided in the county for more than 5 years, and the newcomers who have not. The old-timers also tend to be rural and agrarian. The newcomers tend to be less rural in terms of their pasts, and more urban now because they settle in the cities of Gillette, Douglas, and Casper rather than the rural county areas.

It is possible to distinguish some of the differences and similarities between the two groups by analyzing data collected by the Wyoming Services Project of the University of Wyoming in 1976. The study indicates that newcomers tend to be younger, better educated, more mobile, less rural, and have a lower unemployment rate than their old-timer counterparts in Gillette. Newcomers also depend more on mobile homes for their dwellings than do old-timers. The two groups have similarities in terms of their basic geographic backgrounds and in their racial and religious homogeneity. Both groups have a similar family size and male/female ratio, work about the same average hours per week, have high average incomes relative to the rest of the state or country, and depend heavily on development-related work for their income.

Information collected from respondents in Campbell County, Buffalo, and Douglas about the effects of energy development upon friendliness and community cohesion is presented in Table R2-32. Only one question in the

TABLE R2-31

PERCEPTIONS OF LOSS OF PERSONAL INFLUENCE IN THE COMMUNITY AS A CONSEQUENCE OF ENERGY DEVELOPMENT AMONG RESPONDENTS IN CAMPBELL COUNTY (1974), BUFFALO (1975), AND DOUGLAS (1975)

	Percent of Total				
Item and Location	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Local people will lose control over important decisions that affect the community life (Campbell County, N=219)	17	32	13	30	8
Potential development will lessen my voice in the community (Buffalo, old-timer subsample only, N=160)	1	38	11*	50	0
Potential development will lessen my voice in the community (Douglas, old-timer subsample only, N=166)	1	30	42*	24	4

Source: Paanenen et al. 1976, Uhlmann et al. 1976.

* "Don't Know" responses are included in the "Neutral" category. For the Buffalo old-timers the "Don't Know" responses account for 9% of the subsample, and for the Douglas old-timers the corresponding proportion is 32%.

TABLE R2-32

ATTITUDES ABOUT THE EFFECTS OF ENERGY DEVELOPMENT UPON COMMUNITY COHESION AND FRIENDLINESS, AMONG RESPONDENTS IN CAMPBELL COUNTY (1974), BUFFALO (1975), AND DOUGLAS (1975)

Item and Location	Percent of Total				
	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Campbell County (N=219)					
People will be less united and friendly because of the influx on many newcomers	16	27	17	25	15
Buffalo (Old-timer subsample, N=160)					
Newcomers are friendly and cooperative	1	82	11*	6	1
Interaction between newcomers and old-timers is friendly	0	77	13*	9	1
Newcomers will be good for Buffalo	1	60	17*	20	2
Buffalo (Newcomer subsample, N=91)					
Old-timers are friendly and helpful	13	70	3	11	2
Interaction between newcomers and old-timers is friendly	1	71	10*	15	2
Old-timers think newcomers are good for Buffalo	0	21	23*	48	8
Douglas (Old-timers subsample, N=166)					
Newcomers are friendly and cooperative	2	63	33*	2	0
Interaction between newcomers and old-timers is friendly	1	46	43*	10	0
Newcomers will be good for Douglas	2	49	40*	8	1

TABLE R2-32
(cont'd)

ATTITUDES ABOUT THE EFFECTS OF ENERGY DEVELOPMENT UPON COMMUNITY COHESION AND FRIENDLINESS, AMONG RESPONDENTS IN CAMPBELL COUNTY (1974), BUFFALO (1975), AND DOUGLAS (1975)

	Percent of Total				
Item and Location	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Douglas (Newcomer subsample, N=85)					
Old-timers are friendly and helpful	12	78	5	4	2
Interaction between newcomers and old-timers is friendly	1	44	33*	21	1
Old-timers think newcomers are good for Douglas	0	39	31*	29	1

Source: Paanenen et al. 1976, Uhlmann et al. 1976.

* "Don't Know" responses were included in the "Neutral" category.

Campbell County study (Paanenen et al. 1976) was directly relevant to the issue of community cohesion, and responses to that item suggest that people in Gillette and Campbell County are not at all sure that a continued influx of newcomers will be a good thing for community solidarity. Forty-three percent of the respondents agreed that "people will be less united and friendly because of the influx of many newcomers,"and many (16%) felt strongly that the newcomers would weaken community bonds.

The Campbell County respondents are unusual in their pessimism about the negative consequences of a continued influx of newcomers. In contrast, only 22% of the old-timers in Buffalo disagreed with the statement that "newcomers will be good for Buffalo,"and the proportion taking the negative position in Douglas was even smaller (9%).

Perhaps the most notable finding apparent in Table R2-32 is that the Wyoming communities studied differ in their estimation of the effects of newcomers on community friendliness and unity. Old-timers in Buffalo almost always agreed that newcomers were friendly and that interaction between old-timers and newcomers was positive (83% and 77%, respectively), while oldtimers in Douglas were somewhat less apt to agree that the newcomers were friendly (65%) and considerably less likely to characterize interaction with them as positive (47%). The statements of newcomers in the two communities corroborate this difference. In both towns the newcomers describe the old-timers as friendly and helpful (Buffalo, 83% and Douglas, 90%), but at the same time the Buffalo newcomers are more likely to describe their interaction with old-timers as friendly than are the Douglas newcomers (72% versus 45%).

Another finding relevant to the community cohesiveness is that old-timers are far more supportive of newcomers than the newcomers think they are. In Buffalo, for example, 61% of the old-timers said that newcomers would be good for the town, but only 21% of the newcomers said that they thought the old-timers thought the newcomers were a good thing. The disparity between old-timers' acceptance of newcomers and newcomers' perceptions of that acceptance was smaller in Douglas, but in the same direction: 51% of the Douglas old-timers said that the newcomers would be good for the town, but only 39% of the newcomers said that they perceived the old-timers as defining their arrival as a good thing. Uhlmann and others (1976, p. 57) commented that the newcomers' expectation that they would not be welcomed seemed a consequence of the boom-town stereotype and their definition of how it would affect them as newcomers:

> The mixed perceptions indicate that newcomers enter the community with a certain amount of fear of being rejected by the long term residents. . . this feeling may be bolstered by the boomtown stereotype which depicts old time reidents harboring resentment against the influx of new citizens. At least at this stage of development in Buffalo and Douglas, oldtimers' views do not conform to the stereotype...

It may be that as development proceeds in Douglas and Buffalo, the favorable attitudes toward newcomers will shift to parallel the essentially neutral situation in Campbell County and Gillette, where one-fifth of the people describe their feelings about the effects of the newcomers as "neutral,"and about 40% who do not view the newcomers in negative terms are counterbalanced by another 40% who do. But even this distribution is not essentially a negative one; three-fifths of the people are neutral or positive, three-fifths are neutral or negative. If one seeks negative attitudes which will confirm the boom-town stereotype, they can be found. But the neutral or positive attitudes which do not comfirm the stereotype will be noted, if they are sought out.

The Psychological Environment

The history of rapid energy development in Wyoming, as in other areas of the United States (such as Alaska), often is a record of not only physical but also human damage and waste. In the past, frontier expansion in rural energy-rich areas without adequate planning has left not only scarred topography, but also cities with poor living environments which can cause human psychological problems.

Economic Environment

Information about the economic environment in Gillette and Campbell County is augmented in the site-specific portion of this document.

Population

Table R2-33 summarizes population trends in the eight northeastern counties of Wyoming since 1960. Although Campbell County experienced significant population growth in the 1960s due to oil and gas discoveries, population in the eight-county area as a whole remained relatively stable. It was not until the early 1970s that increased mining of coal in Campbell and Sheridan counties (as well as in nearby areas of Montana) and uranium in Converse County caused local and regional population to grow at a more rapid rate. In addition to the three counties in which the mining operations are situated, outlying areas (particularly Crook and Weston counties) have also experienced population growth since 1970 as a result of mining activities. Natrona County's population has grown at an accelerating rate, due largely to the status of Casper as the region's main trade center. After a long period of stagnation, Johnson County has experienced one of the region's most rapid growth rates since 1975. The small increase in Niobrara County's population between 1976 and 1978 reversed a long decline, although the current population is still almost 20% below Niobrara's 1960 population.

Employment

Table R2-34 shows trends in wage and salary employment by sector between 1970 and 1975. The sector desig-

TABLE R2-33
CURRENT AND HISTORICAL POPULATION

County City	1960 Pop.	1970 Pop.	1970 % Change 1960-1970*	1973 Pop.	1973 % Change 1970-73	1975 Pop.	1975 % Change 1973-75	1978 Pop.	1978 % Change 1975-78
Campbell	5,861	12,957	(8.3)	12,283	(-1.7)	13,090	(3.2)	26,080	(25.8)
Gillette**	3,580	7,763	(8.1)	7,801	(0.2)	8,215	(2.6)	20,450	(35.5)
Other Areas	2,281	5,194	(8.6)	4,482	(-3.4)	4,875	(4.3)	5,630	(4.9)
Converse	6,366	5,938	(-0.7)	6,860	(4.9)	8,048	(8.3)	11,700	(13.3)
Douglas**	2,822	2,677	(-0.5)	3,056	(4.5)	3,839	(12.1)	7,500	(25.1)
Glenrock**	1,584	1,515	(-0.4)	1,868	(7.2)	2,071	(5.3)	2,700	(9.2)
Other Areas	1,960	1,746	(-1.2)	1,936	(3.5)	2,138	(5.1)	1,500	(-11.1)
Crook	4,691	4,535	(-0.3)	4,617	(0.5)	4,883	(2.8)	5,148	(1.8)
Moorcroft	826	981	(1.7)	923	(-2.1)	1,030	(5.6)	1,200	(5.2)
Other Areas	3,865	3,554	(-0.8)	3,694	(1.3)	3,853	(2.1)	3,948	(0.8)
Johnson	5,475	5,587	(0.2)	5,499	(-0.8)	5,728	(2.1)	6,803	(5.9)
Buffalo	2,907	3,394	(1.6)	3,211	(-1.9)	3,385	(2.7)	4,400	(9.1)
Other Areas	2,568	2,193	(-1.5)	2,288	(1.4)	2,343	(1.2)	2,403	(0.8)
Natrona	49,623	51,264	(0.3)	52,197	(0.6)	55,087	(2.7)	73,588	(2.4)
Casper	38,930	39,361	(0.1)	39,597	(0.2)	41,192	(2.0)	50,579	(7.1)
Other Areas	10,693	11,903	(0.8)	12,600	(1.9)	13,895	(5.0)	23,009	(18.3)***
Niobrara	3,750	2,924	(-2.5)	2,886	(-0.4)	2,895	(0.2)	3,020	(1.4)
Lusk	1,890	1,495	(-2.4)	1,586	(2.0)	1,628	(1.3)	2,000	(7.1)
Other Areas	1,860	1,429	(-2.6)	1,300	(-3.1)	1,267	(-1.5)	1,020	(-7.0)
Sheridan	18,989	17,852	(-0.6)	18,816	(1.8)	19,294	(1.3)	22,501	(5.3)
Sheridan	11,651	10,856	(-0.7)	11,088	(0.7)	11,617	(2.4)	13,400	(4.9)
Other Areas	7,338	6,996	(-0.5)	7,728	(3.4)	7,677	(-0.5)	9,101	(5.8)

TABLE R2-33
(cont'd)
CURRENT AND HISTORICAL POPULATION

County City	1960 Pop.	1970 Pop.	1970 % Change 1960-1970*	1973 Pop.	1973 % Change 1970-73	1975 Pop.	1975 % Change 1973-75	1978 Pop.	1978 % Change 1975-78
Weston	7,929	6,307	(-2.4)	6,179	(-0.7)	6,245	(0.5)	6,932	(3.6)
Newcastle	4,345	3,432	(-2.3)	3,389	(-0.4)	3,421	(0.5)	3,455	(0.3)
Other Areas	3,584	2,875	(2.2)	2,790	(-1.0)	2,824	(0.6)	3,477	(7.2)
Region	102,684	107,364	(0.4)	109,337	(0.6)	115,270	(2.7)	155,772	(10.6)
Wyoming	330,066	332,416	(0.0)	352,585	(2.0)	376,309	(3.3)	NA	NA

Source: U.S. Department of Commerce, Bureau of the Census, November 1970, April 1977, July 1977; University of Wyoming 1978.

* Average rate of change, compounded annually.

** 1978 estimates for Gillette, Douglas, and Glenrock may not be strictly comparable with earlier years data because 1978 estimates include urban "sprawl" outside municipal boundaries.

*** The 1978 population was based on actual house counts while the 1975 population was based on census estimates.

NA = Not Available.

TABLE R2-34

WAGE AND SALARY EMPLOYMENT BY COUNTY 1970-75
(Number of Workers is Followed in Parentheses by the Percentage of Total County Employment)

County	Agriculture		Minerals		Construction		Manufacturing	
	1970	1975	1970	1975	1970	1975	1970	1975
Campbell	157 (3.3)	188 (2.9)	1,108 (23.6)	1,402 (21.9)	473 (10.1)	1,031 (16.1)	27 (0.6)	84 (1.3)
Converse	198 (10.5)	239 (7.7)	155 (8.2)	654 (21.0)	177 (9.4)	286 (9.2)	19 (1.0)	42 (1.4)
Crook	130 (11.1)	157 (11.1)	135 (11.6)	190 (13.5)	64 (5.5)	127 (9.0)	120 (10.3)	133 (9.4)
Johnson	184 (10.7)	222 (10.6)	91 (5.3)	183 (8.8)	177 (10.3)	310 (14.8)	90 (5.2)	111 (5.3)
Natrona	230 (1.1)	276 (1.0)	3,361 (16.0)	4,635 (17.4)	1,202 (5.7)	2,161 (8.1)	1,614 (7.7)	1,908 (7.2)
Niobrara	96 (10.6)	116 (13.0)	78 (8.6)	89 (10.0)	56 (6.2)	23 (2.6)	33 (3.6)	31 (3.5)
Sheridan	298 (4.7)	358 (4.9)	244 (3.8)	199 (2.7)	516 (8.1)	700 (9.6)	366 (5.8)	318 (4.4)
Weston	78 (3.8)	93 (4.0)	439 (21.3)	484 (20.6)	26 (1.3)	63 (2.7)	102 (5.0)	250 (10.6)
Region	1,371 (3.4)	1,649 (3.3)	5,611 (14.1)	7,836 (15.6)	2,691 (6.8)	4,701 (9.4)	2,371 (6.0)	2,877 (5.7)
Wyoming	4,956 (4.0)	5,978 (3.7)	11,628 (9.3)	18,300 (11.4)	7,141 (5.7)	14,659 (9.2)	7,373 (5.9)	8,571 (5.4)

TABLE R2-34
(cont'd)

WAGE AND SALARY EMPLOYMENT BY COUNTY 1970-75
(Number of Workers is Followed in Parentheses by the Percentage of Total County Employment)

County	Business and Consumer Services 1970	Business and Consumer Services 1975	Government and Education 1970	Government and Education 1975	Military 1970	Military 1975	Total Wage and Salary Employment 1970	Total Wage and Salary Employment 1975
Campbell	2,157 (46.0)	2,733 (42.7)	767 (16.3)	962 (15.0)	5 (0.1)	4 (0.1)	4,694	6,404
Converse	848 (44.9)	1,332 (42.9)	488 (25.8)	553 (17.8)	3 (0.2)	2 (0.1)	1,888	3,108
Crook	351 (30.1)	416 (29.5)	367 (31.5)	388 (27.5)	0 (0.0)	0 (0.0)	1,167	1,411
Johnson	733 (42.5)	799 (38.2)	448 (26.0)	466 (22.3)	0 (0.0)	0 (0.0)	1,723	2,091
Natrona	10,816 (51.5)	13,680 (51.4)	3,781 (18.0)	3,973 (14.9)	3 (0.0)	2 (0.0)	21,007	26,635
Niobrara	442 (48.7)	425 (47.5)	203 (22.4)	210 (23.5)	0 (0.0)	0 (0.0)	908	894
Sheridan	3,185 (50.0)	3,679 (50.3)	1,750 (27.5)	2,033 (27.8)	6 (0.1)	5 (0.1)	6,365	7,292
Weston	924 (44.9)	953 (40.5)	491 (23.8)	510 (21.7)	0 (0.0)	0 (0.0)	2,060	2,353
Region	19,456 (48.9)	24,017 (47.9)	8,295 (20.8)	9,095 (18.1)	17 (0.0)	13 (0.0)	39,812	50,188
Wyoming	59,667 (47.8)	73,136 (45.7)	34,146 (27.3)	39,308 (24.6)	*	*	124,911	159,952

Source: U.S. Department of Commerce, Bureau of Economic Analysis 1977.

Note: Includes full- and part-time workers.
BEA data on which this table is based delete sector employment where necessary to preserve confidentially.
In preparing this table, estimates were made of deleted items.

* Figures included under government and education.

nations correspond to those used in the University of Wyoming Water Resources Research Institute (WRRI) model. This system of sector classifications differs substantially from that used by the U.S. Bureau of Economic Analysis (BEA), especially in that it combines several BEA sectors (trade; services; transportation, communications, and utilities; and finance, insurance, and real estate) into a single "super-sector"(business and consumer services). As a result, the relative importance of the mining sector, particularly on the individual county level, is understated.

When the sector classifications used by the Bureau of Economic Analysis are used, the importance of mining as a source of employment becomes clearer. According to this classification system, mining emerges as the largest single employer in Campbell and Converse counties. Regardless of sector classifications, however, mining ranks second in Natrona and Weston and third in Crook County, and remains the third largest employer in the region as a whole.

The mining employment category includes only mine operating personnel. Mine construction employment is included in the construction sector along with other types of construction employment. Showing the effects of the increase in energy construction employment, employment in the regional construction sector grew from 6.8% to 9.4% of total wage and salary employment between 1970 and 1975. In Campbell County alone, construction employment grew from 10.1% to 16.1% of the total work force during this period.

The influence of increases in mining and related employment is also seen in low regional unemployment rates. In 1977, the unemployment for the eight counties as a group was 2.9%, compared with 3.6% for Wyoming and 7.0% nationwide. Individual county unemployment rates ranged from a low of 2.6% (Natrona County) to a high of 3.7% (Sheridan County).

Income

Tables R2-35 through R2-37 reflect the developments which were taking place in the eight-county region between 1970 and 1975. Real per capita income in the region, already higher than the national and Wyoming averages in 1970, increased at a faster rate than either the national or the statewide average (see Table R2-35). By 1975, the regional per capita income was 12.5% higher than the nationwide average, and 9% above the average for the state of Wyoming. Natrona and Campbell counties had the highest and second highest per capita incomes, respectively, in the region in 1975. Four counties (Converse, Crook, Niobrara, and Weston) had per capita incomes below the national and statewide average in 1975. Crook County's per capita income was 36% below the 1975 national average and 40% below the corresponding figure for Wyoming.

High incomes in the eight-county region are at least partly offset by the high local cost of living, which in most of the region is considerably higher than the rest of Wyoming. According to quarterly cost of living statistics published by the Wyoming Department of Administration and Fiscal Control, Gillette ranked as the third most expensive out of the 23 communities surveyed. Four others (Douglas, Casper, Sheridan, and Newcastle) ranked in the top ten. Only two communities (Buffalo and Lusk) have cost of living indices lower than Cheyenne, which serves as the benchmark of comparisons.

It should be noted that even though the region is marked by relatively high incomes, Tables R2-36 and R2-37 indicate that the local increase in income has been unevenly distributed among different segments of the population. For example, according to Table R2-36, average weekly wages in the mining and construction sectors have been considerably higher than in the manufacturing, business, and consumer services sectors. In addition, Table R2-37 shows that mining and construction between 1970 and 1975 increased their relative shares in regional earnings, from 15.6% to 22.0% and 9.1% to 12.6% respectively. Campbell County had the highest percentage of local earnings from mining in 1975 (34.4%). With the exception of agricultural sector earnings, other sectors remained relatively stable or declined somewhat in the region as a whole, with business and consumer services remaining the largest overall source of earnings between 1970 and 1975.

Local Services

The services included under this heading comprise those services which a municipality or county provides for its own residents. On the county level, these services generally include law enforcement and fire protection. For municipalities, the range of services is usually expanded to include water, sewer, and solid waste disposal in addition to police and fire protection.

Municipal Police, Fire, Water, and Sewer Services. The following discussion highlights significant trends and major problem areas in the provision of municipal services. Detailed descriptions of service levels and facilities in each community, together with any known plans for improvements or additions, are provided in Technical Reports, available in the Bureau of Land Management Casper District Office.

Based on national and Wyoming averages, the average number of policemen required to provide effective protection is approximately 2 officers per thousand population for communities under 10,000 inhabitants, and 1.7 officers per thousand population for communities over 10,000 population. In order to ensure adequate mobility, most police departments require one police cruiser for every 3 officers (Intermountain Planners, Inc. 1975). Using these guidelines, most municipalities in the eight-county region provide adequate levels of police protection, with the exceptions of Gillette, Moorcroft, Buffalo, and Casper. However, it should be stressed that these ratios are planning guidelines rather than rigidly defined standards, and must be considered in the light of local conditions. For example, according to the Casper Police Chief, Casper's current complement of 1.4 officers per 1,000 population and one patrol car per 3.7 officers is adequate for the city's needs (personal communication, Robert J. Zipay, Casper Police Chief 1978). Buffalo's

TABLE R2-35

TOTAL AND PER CAPITA PERSONAL INCOME, 1970-75
(1975 Dollars)

County	1970 Total	1970 Per Capita	1975 Total	1975 Per Capita	Percent Change in Per Capita Income, 1970-75
Campbell	64,901,000	4,985	80,259,000	6,347	27.3
Converse	31,881,000	5,344	45,566,000	5,695	6.6
Crook	22,693,000	4,379	21,093,000	4,339	-0.9
Johnson	30,772,000	5,482	35,196,000	6,282	14.6
Natrona	302,384,000	5,871	413,769,000	7,582	29.1
Niobrara	16,125,000	5,008	13,475,000	4,718	-5.8
Sheridan	104,830,000	5,844	123,722,000	6,204	6.2
Weston	30,515,000	4,815	36,710,000	5,875	22.0
Region	604,101,000	5,626	769,790,000	6,642	18.1
Wyoming	1,758,016,700	5,263	2,273,900,000	6,079	15.5
United States	1,127,952,000	5,534	1,257,345,000,000	5,902	6.6

Source: U.S. Department of Commerce, Bureau of Economic Analysis 1977.

Note: Data converted to 1975 dollars using Western States Consumer Price Index.

TABLE R2-36

AVERAGE WAGE AND SALARY INCOME BY SECTOR, 1970-75
(in 1975 Dollars)

Sector	Average Wage and Salary Income 1970	1975	Percent Change 1970-75
Agriculture	$ 3,889/yr.	$ 4,353/yr.	11.93
Mining	207.67/wk.	248.34/wk.	19.58
Construction	241.35/wk.	276.27/wk.	14.46
Manufacturing	171.74/wk.	210.85/wk.	22.77
Business and Consumer Services	117.05/wk.	135.08/wk.	15.40
Government/Education	8,347/yr.	9,577/yr.	14.74
Military	11,610/yr.	16,415/yr.	41.39

Source: University of Wyoming 1978.

Note: Data converted to 1975 dollars using Western States Consumer Price Index.

TABLE R2-37

EARNINGS BY SECTOR 1970-75
(Thousands of Current Dollars and as a Percent of Total Earnings)

County	Farm		Manufacturing		Mining	
	1970	1975	1970	1975	1970	1975
Campbell	5,482 (13.9)	462 (0.6)	172 (0.4)	1,242 (1.6)	10,909 (27.6)	26,057 (34.4)
Converse	5,127 (28.7)	2,479 (6.8)	98 (0.6)	355 (1.0)	1,479 (8.3)	10,183 (27.8)
Crook	5,256 (41.5)	-64	780 (6.2)	1,223 (9.6)	865 (6.8)	2,673 (21.1)
Johnson	4,747 (30.8)	1,405 (6.3)	620 (4.0)	1,311 (5.9)	830 (5.4)	3,061 (13.8)
Natrona	2,825 (1.6)	1,458 (0.4)	17,929 (10.1)	33,231 (10.1)	32,605 (18.3)	73,215 (22.2)
Niobrara	2,933 (35.4)	-289	192 (2.3)	248 (3.5)	766 (9.2)	1,469 (20.9)
Sheridan	6,335 (13.0)	2,192 (3.1)	2,756 (5.7)	3,345 (4.7)	1,500 (3.1)	3,000 (4.3)
Weston	2,906 (17.2)	955 (3.5)	1,110 (6.6)	3,356 (12.4)	3,707 (21.9)	8,440 (31.1)
Region	35,611 (10.6)	8,598 (1.5)	23,657 (7.0)	44,311 (7.6)	52,661 (15.6)	128,098 (22.0)
Wyoming	116,984 (11.7)	58,267 (3.3)	64,956 (6.5)	114,370 (6.5)	112,955 (11.3)	303,520 (17.2)

TABLE R2-37
(cont'd)

EARNINGS BY SECTOR 1970-75
(Thousands of Current and as a Percent of Total Earnings)

County	Construction 1970	Construction 1975	Consumer/Business Services 1970	Consumer/Business Services 1975	Government and Education 1970	Government and Education 1975
Campbell	4,985 (12.6)	14,883 (19.6)	15,594 (39.4)	29,404 (38.8)	2,160 (5.5)	3,430 (4.5)
Converse	1,836 (10.3)	4,471 (12.2)	6,617 (37.0)	14,676 (40.0)	2,586 (14.5)	4,263 (11.6)
Crook	772 (6.1)	1,260 (9.9)	2,784 (22.0)	4,261 (33.6)	2,137 (16.9)	3,206 (25.3)
Johnson	1,897 (12.3)	4,983 (22.5)	4,662 (30.2)	7,323 (33.0)	2,573 (16.7)	3,942 (17.8)
Natrona	14,620 (8.2)	36,844 (11.2)	84,099 (47.3)	146,495 (44.4)	24,741 (13.9)	37,227 (11.3)
Niobrara	616 (7.4)	369 (5.3)	2,585 (31.2)	3,486 (49.7)	1,150 (13.9)	1,663 (23.7)
Sheridan	5,331 (10.9)	9,619 (13.7)	21,168 (43.4)	33,290 (47.2)	11,338 (23.3)	18,555 (26.3)
Weston	461 (2.7)	1,087 (4.0)	5,569 (33.0)	9,009 (33.2)	2,739 (16.2)	4,136 (15.2)
Region	30,518 (9.1)	73,516 (12.6)	143,078 (42.5)	247,944 (42.6)	49,424 (14.7)	76,422 (13.1)
Wyoming	81,458 (8.1)	226,279 (12.8)	402,647 (40.2)	699,829 (39.7)	188,283 (18.8)	309,097 (17.5)

TABLE R2-37
(cont'd)

EARNINGS BY SECTOR 1970-75
(Thousands of Current and as a Percent of Total Earnings)

County	Military		Total Income	
	1970	1975	1970	1975
Campbell	254 (0.6)	375 (0.5)	39,556	75,853
Converse	123 (0.7)	221 (0.6)	17,866	36,648
Crook	75 (0.6)	127 (1.0)	12,669	12,686
Johnson	93 (0.6)	148 (0.7)	15,422	22,173
Natrona	872 (0.5)	1,474 (0.4)	177,691	329,944
Niobrara	49 (0.6)	75 (1.1)	8,291	7,021
Sheridan	343 (0.7)	591 (0.8)	48,771	70,592
Weston	104 (0.6)	167 (0.6)	16,596	27,150
Region	1,913 (0.6)	3,178 (0.5)	336,862	582,067
Wyoming	33,499 (3.3)	53,513 (3.0)	1,000,382	1,764,875

Source: U.S. Department of Commerce, Bureau of Economic Analysis 1977.

Note: Where source contains items which have been deleted to preserve employer confidentaility, these items have been estimated.

low police/population ratio of 1.4:1,000 also meets the town's current requirements (personal communication, John Kaffner, Buffalo Police Chief 1978). Conversely, despite nominally favorable ratios of 2.7 officers per 1,000 population and one patrol car per 3 officers, Moorcroft's Police Chief feels his department is understaffed and underequipped to satisfy the town's police protection requirements (personal communication, Robert Green, Moorcroft Police Chief 1978).

Recommended fire department strength is based on the individual town's fire flow, which in turn is derived according to a rather complicated formula based on the town's building composition and layout. However, population may be used to approximate the required fire flow if more detailed data is unavailable (Mountain West Research 1977). Based on population, Gillette, Douglas, Moorcroft, Buffalo, and Lusk all have inadequate fire department strength, which must be remedied by water system improvements and/or the acquisition of additional pumper trucks in order to bring the local fire protection up to acceptable levels. Additional problems are encountered by the Gillette and Sheridan fire departments, which report that they are frequently hindered in responding to fire alarms by heavy coal train traffic on the rail lines which bisect the towns.

Municipalities vary in the adequacy of their water supply treatment facilities. Local water requirements are assessed using an average peak demand factor of 450 gallons per capita, although actual peak demand may vary according to the town's actual mix of residential, commercial, and industrial water users (Mountain West Research 1977). Local water supplies in Glenrock, Buffalo, Lusk, and Sheridan are adequate; the remaining communities either are undertaking or plan to undertake water system improvements to meet current and future demand.

Municipal sewage treatment facilities can be evaluated by type, capacity (using an average demand factor of 168 gallons of sewage per capita daily), or Environmental Protection Agency ratings. Current sewage treatment facilities in Gillette, Glenrock, Casper, and Newcastle are adequate to meet the present demand, but facilities serving unincorporated areas around Gillette are marginally adequate, and facilities serving the remaining municipalities are either operating at maximum capacity (Lusk) or are inadequate (Douglas, Moorcroft, Buffalo, and Sheridan). Due to the high cost of constructing modern sewage treatment facilities, most of these communities face difficulties in obtaining sufficient funds for the needed improvements.

County Police and Fire Services. The rural, sparsely settled nature of most county lands makes it difficult to assess the capability of county law enforcement and fire protection agencies using published standards and planning guidelines, all of which were derived with an urbanized population in mind. Based on contacts with the various county sheriffs and fire marshalls, all jurisdictions have problems extending police and fire services to residents of remote unincorporated areas; such problems are characteristic of sparsely populated states like Wyoming. This situation is especially true of the county fire departments in the eight-county region.

Education

Many of the school systems in the eight-county region have undergone significant changes as a result of the increased mining activity in the region. The three districts with the greatest enrollment increases between 1974 and 1977 are Gillette, in Campbell County, (41.5%) and the two Converse County districts, where Douglas experienced a 55.8% rise, and Glenrock, a 25.7% increase (see Table R2-38). Overall, the area percentage increase in enrollment was 12.6%, compared with the statewide increase of 7.8% for the same period. The pupil/ teacher ratio remained fairly stable over this same 3-year period, increasing by only 0.3 pupils per teacher (see Table R2-38) for the entire area in spite of the significant enrollment increases in the heavily impacted counties. This would indicate that by and large, the school districts have been able to maintain adequate standards in this area.

School building capacity is more difficult to measure. The state of Wyoming does not collect data on school building capacity. State figures measure capacity only for purposes of its School Foundation Program. The resulting figures, called classroom units (CRUs), represent a measure of financial need, weighted according to size and type of class in such a way as not to be useful within the context of the present analysis (Wyoming State Department of Education 1976).

Capacity figures presented in Table R2-38 are estimates provided through contacts with the superintendents of the respective school districts. In several cases, officials found it extremely difficult to provide accurate estimates. This should serve as a caution to the reader regarding the precision of the data. However, the capacity figures presented in Table R2-38 are useful as a general guide to adequacy of space in the various districts.

Funding the needed school improvements has not been a severe problem, and the heavily impacted mining communities have managed adequate expansion. According to Table R2-39, revenues and expenditures per average daily member (ADM) for the eight-county region are significantly higher than the statewide figures: $2,062 in revenues per ADM, compared to the statewide figure of $1,781, and $1,926 in expenditures per ADM, compared to the Wyoming figure of $1,721.

Finally, the qualitative changes experienced by the school systems demand consideration. The chief change common to all of the impacted areas is that the itinerant character of the new population has created a demand for more special education and counseling services. This need is being met with varying degrees of intensity among the districts in the eight-county region.

Housing

Table R2-40 depicts changes in the local housing stock between 1970 and 1977. The largest proportional in-

TABLE R2-38

SCHOOL ENROLLMENT, PUPIL/TEACHER RATIO, PERCENTAGE INCREASES IN ENROLLMENT, SYSTEM FACILITY CAPACITY
1974-75 and 1977-78

County / School District	1974-75 Enrollment	1974-75 Pupil/ Teacher Ratio	1977-78 Enrollment	1977-78 Percentage Increase 1974-77	1977-78 Pupil/ Teacher Ratio	1977-78 Percent of School Capacity* Occupied
Campbell-Gillette School District #1	3,186	15.5	4,509	41.5	14.5	95.0
Converse-Douglas School District #1	1,193	17.3	1,859	55.8	18.1	99
Converse-Glenrock School District #2	703	18.8	884	25.7	18.9	78.6
Converse County Total	1,896	18.1	2,743	44.7	18.5	88.9
Crook-Sundance School District #1	1,233	14.4	1,332	8.0	14.9	95.0
Johnson-Buffalo School District #1	1,265	16.6	1,415	11.9	17.3	91.3
Natrona-Casper School District #1	13,256	20.8	13,783	4.0	22.1	99.9
Niobrara-Lusk School District #1	622	15.0	617	0.8	15.1	90.0
Sheridan-Ranchester School District #1	627	13.9	736	17.4	16.7	97.6
Sheridan-Sheridan School District #2	3,285	20.5	3,537	7.7	21.1	99.0

TABLE R2-38
(cont'd)

SCHOOL ENROLLMENT, PUPIL/TEACHER RATIO, PERCENTAGE INCREASES IN ENROLLMENT, SYSTEM FACILITY CAPACITY
1975-75 and 1977-78

County School District	1974-75 Enrollment	1974-75 Pupil/ Teacher Ratio	1977-78 Enrollment	1977-78 Percentage Increase 1974-77	1977-78 Pupil/ Teacher Ratio	1977-78 Percent of School Capacity* Occupied
Sheridan-Clearmont						
School District #3	130	8.4	143	10.0	9.5	84.1
Sheridan County Total	4,042	14.3	4,416	9.3	15.7	----
Weston-Newcastle						
School District #1	1,269	16.4	1,290	1.6	16.2	77.8
Weston-Upton						
School District #7	372	14.3	426	14.5	13.4	71.0
Weston County Total	1,641	15.4	1,716	4.6	14.8	74.4
Eight-County Area	27,141	16.3	30,570	12.6	16.6	----
Wyoming	86,584	18.5	93,321	7.8	18.4	----

Source: Wyoming Department of Education 1974 through 1977.

* These figures are based on estimates provided by primary contacts in the respective school districts. Excludes rural schools.

TABLE R2-39
ADMs, ASSESSED VALUATION, SCHOOL LEVIES, REVENUES, AND EXPENDITURES
1974-75 and 1976-77

County School District	1974-75							
	ADMs	Total Assessed Valuation	Assessed Valuation/ ADM	Total School Levy	Total Revenues	Revenues/ ADM	Total Expen- diture	Expen- diture/ ADM
Campbell								
Gillette	3,320	193,005,737	58,134	42.630	7,580,378	2,283	7,639,069	2,301
Converse								
Douglas	1,224	65,936,827	53,870	44.060	2,451,161	2,003	2,406,888	1,966
Glenrock	692	18,967,852	27,410	52.335	976,767	1,412	919,621	1,329
Crook								
Sundance	1,256	35,018,527	27,881	43.415	2,055,722	1,637	2,083,393	1,659
Johnson								
Buffalo	1,269	36,397,885	28,682	40.645	1,830,381	1,442	1,810,872	1,427
Natrona								
Casper	13,289	179,848,258	13,534	46.160	14,204,865	1,069	14,115,142	1,062
Niobrara								
Lusk	610	19,721,374	32,330	39.523	994,575	1,630	1,003,548	1,645
Sheridan								
Ranchester	637	9,166,178	14,390	49.870	917,100	1,440	940,209	1,476
Sheridan	3,274	31,878,246	9,737	47.660	3,512,319	1,073	3,744,182	1,144
Clearmont	113	4,593,783	40,653	47.140	248,799	2,202	267,668	2,369
Weston								
Newcastle	1,248	26,063,638	20,884	43.951	1,585,139	1,270	1,632,759	1,308
Upton	396	9,351,282	23,614	45.308	553,579	1,398	551,338	1,392
Regional	29,328	629,949,587	23,051		36,910,785	1,351	37,114,689	1,358
Wyoming	85,996	1,708,945,746	19,872		113,246,446	1,317	112,896,813	1,313

TABLE R2-39
(cont'd)
ADMs, ASSESSED VALUATION, SCHOOL LEVIES, REVENUES, AND EXPENDITURES
1974-75 and 1976-77

County School District	1976-77 ADMs	Total Assessed Valuation	Assessed Valuation/ ADM	Total School Levy	Total Revenues	Revenues/ ADM	Total Expen-diture	Expen-diture/ ADM
Campbell								
Gillette	4,091	356,605,292	87,168	45.640	12,315,969	3,011	10,526,595	2,573
Converse								
Douglas	1,648	140,509,046	85,260	50690	4,955,939	3,007	3,751,419	2,276
Glenrock	789	40,015,370	50,717	51.210	1,933,568	2,451	1,836,038	2,327
Crook								
Sundance	1,298	51,090,059	39,361	46.420	2,673,657	2,060	2,603,011	2,005
Johnson								
Buffalo	1,370	59,003,449	43,068	44.151	2,619,549	1,912	2,511,073	1,833
Natrona								
Casper	13,631	212,785,370	15,610	49.950	18,337,481	1,345	18,855,389	1,383
Niobrara								
Lusk	681	23,918,473	35,123	43.967	1,281,311	1,882	1,253,571	1,841
Sheridan								
Ranchester	674	9,459,188	14,034	44.660	1,147,362	1,702	1,157,648	1,718
Sheridan	3,409	43,855,810	12,865	49.471	4,744,756	1,392	4,631,737	1,359
Clearmont	137	4,413,575	32,216	47.243	317,172	2,315	295,009	2,153
Weston								
Newcastle	1,294	35,469,608	27,411	49.576	2,264,100	1,750	2,074,695	1,603
Upton	468	14,887,488	31,811	46.805	818,142	1,748	819,688	1,752
Regional	29,490	992,012,728	33,639		53,409,006	1,811	50,315,873	1,706
Wyoming	90,043	2,804,216,938	31,143		160,287,848	1,781	154,967,697	1,721

Source: Wyoming Department of Education 1974 through 1977.

TABLE R2-40

HOUSING SUPPLY

City	1970 Total Units	1970 Single Family (Percent)	1970 Multi-Family (Percent)	1970 Mobile Homes (Percent)	1977 Total Units	1977 Single Family (Percent)	1977 Multi-Family (Percent)	1977 Mobile Homes & Misc. (Percent)
Gillette*	2,228	1,139 (51.1)	444 (19.9)	645 (28.9)	3,845	1,623 (42.2)	680 (17.7)	1,532 (40.1)
Wright	0	--	--	--	233	0 (0.0)	0 (0.0)	233 (100.0)
Douglas	1,066	795 (74.6)	197 (18.5)	74 (6.9)	1,788	1,232 (68.9)	207 (15.4)	349 (19.5)
Glenrock	514	NA	NA	NA	661	439 (66.4)	63 (9.5)	159 (24.1)
Moorcroft	NA	NA	NA	NA	297	147 (49.5)	0 (0.0)	150 (50.5)
Buffalo**	1,295	1,007 (77.8)	227 (17.5)	61 (4.7)	1,621	1,398 (86.2)	93 (5.7)	130 (8.1)
Casper	13,365	10,246 (76.7)	2,914 (21.8)	205 (1.5)	16,269	12,034 (74.0)	3,580 (22.0)	655 (4.0)
Lusk	712	NA	NA	NA	720	NA	NA	NA
Sheridan***	4,434	3,454 (77.9)	924 (20.8)	56 (1.3)	5,250	3,993 (76.1)	477 (9.1)	780 (14.8)
Newcastle	1,226	974 (79.4)	163 (13.3)	89 (7.3)	1,368	950 (69.4)	246 (18.0)	172 (12.6)

Source: U.S. Department of Commerce, Bureau of the Census 1972; City of Gillette-Campbell County Department of Planning and Development 1978; and personal communications, Al Straessle, Converse County Planning Department; Abbie Birmingham, Tri-County Planner (Crook-Niobrara-Weston Counties); Ken Gross, Town Planner, Buffalo; Lee West, Casper City Planner's Office; Joseph Hollingsworth, Sheridan County Planner 1978.

* Gillette data do not include housing units located immediately outside municipal boundaries. In 1977, these housing units numbered 5,295.

** Buffalo data as of early 1978.

*** Sheridan data as of mid-1976.

NA = Not available.

creases in housing capacity have occurred in Gillette (72.5% between 1970 and 1975, or an average of 8.1% annually) and Douglas (73.7% or 8.2% annually) during the same period. In most other communities the total housing stock grew between 20% and 30% over the 7-year period. Exceptions include Newcastle, where the 7-year increase was limited to just 7.8%, and Lusk, where the total number of housing units remained virtually stable at 1970 levels.

Much of this overall increase in housing consisted of mobile homes, particularly in Gillette, where mobile homes grew from 32% to 40% of the total housing stock between 1970 and 1977. Mobile homes also increased significantly as a share of the total housing stock in Douglas, where they increased from 10.2% to 19.5% of the total housing inventory between 1970 and 1977, and in Sheridan, where they increased from 1.3% to 14.8% of the total stock of housing between 1970 and 1976 (the most recent year for which statistics are available). In all communities except Buffalo, single-family housing declined in relation to the total number of housing units during the period under study. The proportion of multi-family (e.g., apartment, duplex) units also declined in most communities, but especially Sheridan, where nearly 500 dwelling units in multi-family structures were taken off the market between 1970 and 1976.

These shifts are primarily a product of changing personal housing preferences among the population, as well as inflation in the cost of housing. According to Table R2-41, while more than 80% of the long-term residents of western communities experiencing rapid energy-related population growth typically prefer single-family housing, new residents (especially construction workers) express greater acceptance of multi-family and mobile housing. In part, this shift in preferences reflects the newcomers' own perception of their transient status and lack of local roots. However, for many households, economics rather than subjective preference plays the decisive role in determining their final choice of housing type. Spiraling housing costs in many northeastern Wyoming communities have placed single home ownership beyond the means of many households, particularly those whose primary breadwinners are employed outside the relatively high-paying mining and construction sectors. Table R2-42 compares the median cost of single-family and multi-family (rental) housing in different local housing markets.

Table R2-43 places housing cost data in the context of an individual household's ability to pay these costs. Based on the common banker's rule of thumb that housing costs should take up no more than one-third of a household's income, it is immediately apparent that ownership of single-family housing is beyond the financial means of most households, except those with breadwinners in the energy or construction sectors, or with multiple wage earners.

Health Services

Tables R2-44 and R2-45 display data on health care facilities and personnel in the eight-county region. Although each county in the region has a hospital to serve the needs of its residents, the overall ratio of population to hospital beds in the eight-county region is almost 60% higher than the national average. Despite the high ratio of population to hospital beds, the regional hospital utilization ratio of 0.59 bed-days per capita is substantially below the nationwide average of 1.92. This indicates, among other factors, that many residents are traveling outside the region to obtain medical care, motivated by the scarcity of physicians, and the relatively narrow range of services offered in the region's hospitals.

Campbell County is currently served by the 31-bed Campbell County Memorial Hospital, and has an extremely high population/bed ratio of 841:1, compared with the regional average of 283:1. However, utilization of Campbell County's hospital in bed-days per capita is less than one-third of the eight-county regional average. Evidently a sizable portion of Campbell County residents travel outside the county for medical care, a pattern which is repeated in most other counties. Natrona County, with the widest range of health care capabilities in the region, functions as a regional health care center for many residents. The 61% occupancy rate of Natrona County Memorial Hospital allows considerable room for growth before additional facilities will be required. Natrona County, along with Sheridan County, is one of the only two counties in the region with an adequate supply of physicians, registered nurses, and dentists compared with recommended standards. The average availability of health care personnel in other counties is much less favorable, especially in Crook County, which has been designated a medical scarcity area by the Wyoming Department of Health and Social Services (1977).

Retail Trade

Between 1972 and 1975, total retail sales in the eight-county region increased 9.7% when measured in constant dollar terms (see Table R2-46). On a per capita basis, retail sales in the eight-county region (measured in constant dollars) increased by 2.7%. Most of this increase was concentrated in Natrona County (i.e., Casper) in its role as the region's main trade center. However, available data for 1977 indicate that Campbell County (Gillette) and Sheridan County (Sheridan) are becoming increasingly important as regional trade centers.

Natrona County's disproportionate gain is due to its increasing status as a trade center for residents of other counties, including those outside the eight-county region (e.g., Carbon County). Additional evidence to support this conclusion is found in Table R2-47. According to this table, Natrona County accounted for 56.6% of regional retail sales in 1975, compared with 35.5% of the population. The data also indicate that Natrona County attracted an increasing percentage of regional retail sales between 1972 and 1975. Campbell and Converse counties maintained their proportional share in regional retail trade, while the remaining five counties captured decreasing shares of total retail sales in the eight-county region.

TABLE R2-41

HOUSING PREFERENCES

Type of Unit	Long-time Residents	New Construction Workers	Other New Residents
		Type of Housing Preferred* (percent)	
Single Family	86.9	45.6	70.9
Multi-family	3.4	8.8	10.7
Mobile Home	8.8	38.0	17.1
Other	0.9	7.6	1.3
		Type of Housing Demanded* (percent)	
Single Family	80.7	34.3	55.1
Multi-family	5.1	10.6	17.2
Mobile Home	13.4	45.6	25.4
Other	0.9	9.8	2.3

Source: Old West Regional Commission 1975.

Note: Numbers do not add to 100 percent due to rounding.

* Housing "preference" is the response to a question "What type of housing would you like to live in?" Housing "demand" is the response to a question "What type of housing would you be willing and able to move into if it were available?"

TABLE R2-42

CITY HOUSING MARKET CHARACTERISTICS, 1977-78

City	Total Units	Median Cost of Single-Family Home	Median Per Month Rental Unit Cost
Gillette	3,845	$ 55,000	$ 375
Wright	328	---	---
Douglas	1,788	50,000	325
Glenrock	661	50,000	325
Moorcroft	297	42,000	250
Buffalo	1,621	55,000	250
Casper	16,269	46,000	300
Lusk	720	50,000	250
Sheridan	5,250	58,000	250
Newcastle	1,354	40,000	250

Sources: Wyoming Department of Economic Planning and Development Industrial Development Division 1977; personal communications, Ken Gross, Town Planner, Buffalo; Crystal Perry, City Clerk, Lusk; Abbie Birmingham, Tri-County Planner (Crook/Niobrara/Weston County); and Al Straessle, Converse County Planning Commission, 1978.

TABLE R2-43

ABILITY OF CONSUMERS TO PAY FOR NEW HOUSING

Type of Worker Type of Unit	1977 Estimated Monthly Cost*	1977 Percent of Monthly Income**
Construction Workers		
Single Family	$310-$480	23-36
Multi-Family	$250-$375	19-28
Mobile Home	$250-$285	19-22
Energy Mining Industry Workers		
Single Family	$310-$480	26-40
Multi-Family	$250-$375	21-31
Mobile Home	$250-$285	21-24
Other Workers		
Single Family	$310-$480	40-61
Multi-Family	$250-$375	32-48
Mobile Home	$250-$285	32-36

Sources: Personal communication, Tom Schaler, Wyoming Manufactured Housing Association 1977; Wyoming Department of Economic Planning and Development, Planning Division March 1977; typical local housing costs from Table R2-42, City Housing Market Characteristics.

* In larger communities close to employment opportunities (such as Sheridan or Douglas) housing costs are noticeably higher than for smaller, more distant communities (such as Newcastle or Moorcroft). The range of values shown represents the difference between the cost of typical housing in these low-cost and high-cost communities, respectively. For a low-cost community a typical three bedroom home is $40,000, a typical three-bedroom apartment is $250 per month, and a typical site in a mobile home park is $65 per month. For a high-cost community a typical three-bedroom home can cost up to $60,000, a typical three-bedroom apartment is $325 per month, and a typical site in a mobile home park is $100 per month. Monthly costs are calculated by making the following assumptions. Single-family homes are financed with 20% down, 30-year loans at 9.25% interest. Mobile homes cost $14,000 and are financed with 20% down 15-year loans at 12% interest. Property taxes are estimated assuming taxable valuation equals one-third of property's market value, and tax rate is 50 mills per dollar of assessed valuation.

** 1977 monthly income was derived from the WRRI model's estimates of 1977 average weekly earnings for production workers in the eight-county region (University of Wyoming 1978). Categories were combined using a weighted average based on the number of workers employed in each sector.

TABLE R2-44

HEALTH FACILITIES - 1977

County	1977 Population	Hospitals					Ambulances		Nursing Care Facilities			
		Number	Beds	Occupancy (%)	Population/ Bed	Bed-Days/ Population	Number	Population/ Ambulance	Number	Beds	Occupancy (%)	Population/ Bed
Campbell	26,080	1	31	51	841	0.22	2	13,040	1	120	95	217
Converse	11,700	1	32	48	366	0.48	4	2,975	1	59	92	198
Crook*	5,148	1	16	16	322	0.18	3	1,716	0	0	--	---
Johnson	6,803	1	26	57	262	0.79	5	1,361	1	40	81	170
Natrona	73,588	1	297	61	247	0.90	8	9,198	3	247	89	248
Niobrara	3,020	1	24	31	126	0.90	2	1,510	1	12	93	252
Sheridan	22,501	1	89	67	253	0.97	5	4,500	1	120	93	188
Weston	6,932	1	36	38	193	0.72	3	2,310	1	41	92	169
REGION	155,772	8	551	46	283	0.59	32	4,868	9	639	79	244
WYOMING	424,156	27**	1,649	53	257	0.85	129	3,288	27	1,823	86	233
NATION	213,819,00	7,156	1,465,828	77	146	1.92	--	---	--	---	--	---

Sources: University of Wyoming 1978; Wyoming Department of Health and Social Services 1977; personal communication. Larry Bertilson, State Health Planning Manager 1978; American Hospital Association 1976.

* Crook county has been designated a medical scarcity area by the Wyoming Department of Health and Social Services.

** Excludes the Wyoming State Hospital, two Veterans' Administration hospitals, and the Warren Air Force Base hospital. Occupancy based on 22 hospitals for which data were available.

TABLE R2-45

HEALTH CARE PERSONNEL 1977
(Ratio of Population to Health Care Specialist)

County	1978 Population	Physicians	Psychologists	Registered Nurses	Licensed Practical Nurses	Pharmacists	Dentists
Campbell	26,080	2,898	13,040	492	1,185	186	6,520
Converse	11,700	1,950	11,700	403	1,300	1,170	5,850
Crook*	5,148	2,574	--**	468	--**	2,574	5,148
Johnson	6,803	1,701	--**	227	618	972	3,402
Natrona	73,588	920	18,397	192	381	1,168	2,164
Niobrara	3,020	1,510	--**	252	604	3,020	3,020
Sheridan	22,501	865	7,500	146	682	865	1,406
Weston	6,932	2,311	--**	267	990	1,155	3,466
Region	155,772	1,189	17,308	223	550	1,208	2,512
Wyoming	424,156	1,082	7,069	206	582	1,181	2,232
Recommended Standards		1,000	--	285	--	--	1,600

Sources: University of Wyoming 1978; Wyoming Department of Health and Social Services, 1977; personal communication, Larry Bertilson, State Health Planning Manager 1978.

Note: Data are from August 1977. The number of physicians used for the calculations is the number of active physicians, which is lower than the actual number of licensed physicians.

* Crook County has been designated a medical scarcity area by the Wyoming Department of Health and Social Services.

** No health care specialist in this category.

TABLE R2-46

TRENDS IN TOTAL AND PER CAPITA RETAIL SALES, 1972-75
(1975 Dollars)

County	1972 Total Retail Sales	1972 Per Capita Retail Sales	1975 Total Retail Sales	1975 Per Capita Retail Sales	Percent Change 1972-75 Total Retail Sales	Percent Change 1972-75 Per Capita Retail Sales
Campbell	$ 41,357,000	$ 3,423	$ 44,081,000	$ 3,362	6.6	-1.8
Converse	16,372,000	2,443	18,033,000	2,240	10.1	-8.3
Crook	6,612,000	1,407	6,666,000	1,365	0.8	-3.0
Johnson	15,676,000	2,903	14,673,000	2,562	-6.4	-11.7
Natrona	184,388,000	3,486	214,571,000	3,895	16.4	-11.7
Niobrara	8,901,000	3,070	8,635,000	2,983	-3.0	-2.8
Sheridan	59,961,000	3,295	59,374,000	3,077	-1.0	-6.6
Weston	14,130,000	2,316	13,696,000	2,193	-3.1	-5.3
Region	346,104,000	3,190	379,729,000	3,276	9.7	2.7
Wyoming	1,053,805,000	3,047	1,092,250,000	2,903	3.6	-4.7

Source: Sales and Marketing Management Magazine 1976.

Note: 1972 dollars converted to 1975 dollars using Western States Conversion Price Index.

TABLE R2-47

COUNTY SHARES IN TOTAL REGIONAL SALES, 1972-1975

County	1972 Retail Sales	1972 Percent Share in Total Regional Sales	1975 Retail Sales	1975 Percent Share in Total Regional Sales
Campbell	$ 31,021,000	11.6%	$ 44,081,000	11.6%
Converse	12,676,000	4.7	18,033,000	4.7
Crook	5,119,000	1.9	6,666,000	1.8
Johnson	12,137,000	4.5	14,673,000	3.9
Natrona	142,763,000	53.3	214,571,000	56.6
Niobrara	6,892,000	2.6	8,635,000	2.3
Sheridan	46,425,000	17.3	59,374,000	15.6
Weston	10,940,000	4.1	13,696,000	3.6
Region	267,973,000	100.0	379,729,000	100.0

Source: Sales and Marketing Management Magazine 1976.

Unfortunately, comparable data on retail sales for more recent years are not available. For technical reasons, 1977 retail sales estimates based on Wyoming sales tax collections are not directly comparable with earlier data. However, these 1977 estimates of retail sales can be used to form some idea of each county's relative share in current retail sales. Retail sales tax data indicate that since 1975, Campbell, Converse, Crook, Sheridan, and Weston counties have succeeded in capturing a larger percentage of regional retail sales. Natrona County, on the other hand, is attracting a smaller share of regional retail sales, due partly to the rise of secondary regional trade centers such as Gillette in Campbell County. Johnson and Niobrara counties' share in regional sales has continued to decline.

Regional trade tends to be organized around two trade centers: Casper and, to a lesser extent, Sheridan. Casper attracts buyers from as far as Carbon County, Wyoming, while Sheridan's sphere of attraction extends into southeastern Montana. On the other hand, many residents of the easternmost counties of the eight-county region, particularly Weston and Niobrara, travel occasionally to Rapid City, South Dakota to shop. Within Campbell and Converse counties, Gillette residents often travel to Sheridan to make purchases, while Gillette itself acts as a sales magnet to many residents of neighboring small counties such as Crook and Niobrara. The net result is that it is extremely difficult to ascertain the extent to which a given county is capable of meeting its residents' own retail trade needs. It is even more difficult to estimate the extent to which an increase in local personal income related to mining employment will be translated into increased local retail sales in a given county.

Local Finances

Local communities in the eight-county region vary widely in their fiscal characteristics. Table R2-48 summarizes the salient characteristics of local finances in a format which facilitates comparisons and provides general indicators of fiscal conditions in the various communities and their ability to respond to the fiscal demands of future population growth. (School district finances are discussed separately under education.)

The assessed valuation of a community measures its potential ability to raise additional funds through property taxes, either by increases in the property tax base or by raising the mill levy (property tax rate). The property tax base can increase as a result of additional industrial, commercial, or residential development; or an increase in property market values; or an increase in the assessment ratio (in Wyoming, property is generally assessed at 25% of its market value, called the assessment ratio). The extent to which municipalities can raise the property tax rate is limited by law (8 mills for purposes other than repayment of debt and interest, plus an unlimited rate for debt and interest repayment), although in practice many communities have been able to circumvent this requirement. The county limit of 12 mills applies only to tax levies for counties' own operating purposes; again, there are various legal means of circumventing this requirement.

Assessed valuation can be compared most meaningfully on a per capita basis. In general, Campbell and Converse counties have a much higher per capita valuation than municipalities. The county tax base includes all property within the county boundaries (especially mineral-producing property), while the municipal tax base includes only property within the town or city limits (mostly residential and commercial property). For example, Campbell County's per capita assessed value (including oil and gas development) is $13,397, compared with $761 for the city of Gillette. As a result, while municipalities are expected to bear the burden of providing most of the additional services required by future population resulting from energy development, most of the property tax benefits of this development will go to the counties where the mineral deposits are located. The municipalities will benefit only to the extent of additional assessment on worker housing and commercial development within their boundaries. In view of the legal ceiling on property tax rates, the capacity of municipalities to increase property tax revenues by raising the tax rate is quite limited.

As a result, most municipalities will in the future become increasingly dependent on nonproperty tax revenues, both from local sources (e.g., sales taxes, permits, and license fees) and from the state and federal governments. The latter includes, but is not necessarily restricted to the following types of revenues.

Federal Transfers. Federal revenue sharing is an important revenue component. In addition, communities may be eligible to obtain grants or loans to finance infrastructure construction from federal agencies such as the Economic Development Administration, the Environmental Protection Agency, and the Farmers Home Administration.

Mineral Revenues. Communities receive 7.5% of mineral leasing royalties received by the state (from federal leases), and the county receives 2.25%. Other portions of the leasing royalties are earmarked for education and roads.

Severance Taxes. State severance taxes for coal are 10.1% of the value of gross production. These taxes accrue directly to the state and are not returned to communities. However, a portion of the severance taxes is passed to the State Farm Loan Board to run a grant and loan program for energy-impacted communities. Such grants and loans are often used for street and capital improvement projects.

Per capita operating expenditures, the amount each jurisdiction spends on providing services to its residents (excluding lump-sum capital expenditures on major new facilities and equipment items, but including debt service payments), also vary widely among individual communities. Although there is a tendency for larger communities such as Gillette or Douglas to spend more per capita on services than small communities like Moorcroft, it is impossible to generalize about Eastern Powder River Basin communities. For example, Sheridan, with a 1978 population of 13,400, spent $317 per capita on operating ex-

TABLE R2-48

SUMMARY TABLE: FISCAL CHARACTERISTICS OF COUNTY AND MUNICIPAL GOVERNMENTS, FISCAL 1977-78

County / City	1978 Estimated Population	Property Tax Base: Assessed Value Total	Property Tax Base: Per Capita	Property Tax Base: Mill Levy	Operating Expenditures*: Total	Operating Expenditures*: Per Capita	Total Debt and Legal Debt Margin**: Total Debt	Total Debt and Legal Debt Margin**: Legal Debt Margin (if applicable)
Campbell	26,080	349,395,990	13,397	14.229	7,665,298	294	200,000	6,905,753
Gillette	20,450	15,570,717	761	7.50	7,348,296	359	2,811,656	1,245,657
Converse	11,700	180,524,416	15,429	8.638	4,292,352	387	1,500,000	2,110,488
Douglas	7,500	6,971,010	929	10.74	1,922,840	256	266,000	
Glenrock	2,700	2,334,375	865	9.134	916,712	340	360,000	N/A
Crook	5,148	51,090,059	9,924	16.298	1,794,123	349	0	1,021,801
Moorcroft	1,200	1,308,563	1,090	8.00	177,700	148	50,500	N/A
Johnson	6,803	59,003,449	8,673	11.988	1,371,695	202	60,000	1,180,069
Buffalo	4,400	5,391,235	1,225	16.699	961,720	219	540,000	N/A
Natrona	73,588	212,000,000	2,881	11.150	27,182,115***	369	0	4,240,000
Casper	50,579	8,550,777	1,612	8.00	7,550,805	149	2,032,000	652,406
Niobrara	3,020	23,565,944	7,803	12.312	843,649	279	590,000	0
Lusk	2,000	3,007,976	1,504	8.00	985,956	493	0	N/A
Sheridan	22,501	57,728,573	2,565	13.147	7,207,675	320	655,000	499,571
Sheridan	13,400	23,452,389	1,750	11.543	4,243,483	317	1,760,000	1,876,192
Weston	6,932	47,138,199	6,800	11.064	2,730,843	394	0	942,764
Newcastle	3,455	5,134,305	1,486	14.305	1,340,983	388	742,000	N/A

Sources: Wyoming Department of Revenue and Taxation 1977; Local budgets.

* Total outlays minus any identifiable nonrecurrent expenditures over $10,000.

** County debit is legally limited to 2% of total assessed value. Municipal debt limits apply only to Class I cities (Gillette, Douglas, Casper, Sheridan): the latters' indebtedness is limited to 4% of assessed value for general obligation bonds, plus 4% for sewer bonds (all other bonds are exempt).

*** General fund only.

penditures, compared with Lusk's operating outlays of $493 per capita for a population less than one-sixth the size of Sheridan's.

Communities may finance needed capital improvements (e.g., water system improvements or new sewage treatment facilities) either out of current revenues or by going into debt. Legal restrictions limit the ability of counties and the larger municipalities (Gillette, Douglas, Casper, and Sheridan) to incur debts. Counties may not incur debts exceeding 2% of their assessed valuation. Class I cities (i.e., Gillette, Douglas, Casper, and Sheridan) may borrow up to 4% of their assessed valuation in general obligation bonds, plus another 4% to finance sewer system improvements; other types of indebtedness are exempt from restriction. In addition to their legal ability to incur debt, communities must convince potential investors of their long-term financial viability in order to sell their bonds. Subject to this constraint, however, most communities (except Niobrara County) currently have additional unused bonding capacity.

FUTURE ENVIRONMENT

The following portion of Chapter 2 briefly describes alterations which will occur in the Eastern Powder River Basin by 1990, assuming that the site-specific action (Buckskin) is not authorized. Detailed analyses of changes expected in the region can be found in Chapters 4 and 8 (No Action Alternative).

Historically, regional activity has centered around agriculture and the railroads. Since the 1950s, activity has shifted toward energy development, and it is now apparent that the region's future is tied to that development.

Between 1978 and 1990, approximately 63,000 acres will be disturbed for coal mines and processing plants, uranium mines and mills, oil and gas sites, quarries, roads and utility lines, and urban expansion. By 1990, about 26,000 of these acres will have been reclaimed, primarily to smoothly rolling grassland; of the remaining acres, about half will be characterized by open pit and spoil topography, and the other half will be occupied by mineral processing facilities, housing, or other structures. Only the acres reclaimed will be available for livestock grazing, wildlife habitat, or other land uses.

From 1978 to 1990, approximately 1,800 million tons of coal will be mined in the region, and converted to electric power or synthetic natural gas, or exported and consumed elsewhere.

Regional development will gradually increase total suspended particulate (TSP) levels, particularly around and between Gillette and Reno Junction, but not beyond Wyoming air quality standards. Combustion emissions will increase near urban areas and roadways. However, only insignificant changes in visibility and ambient concentrations of TSP, nitrogen dioxide, and sulfur dioxide are expected in the remainder of the region.

Total regional water use is projected to increase 2,175 acre-feet every year through 1990. The quality of surface and groundwater may be reduced by sediment and/or higher concentrations of dissolved solids in the vicinity of mines and replaced spoils (see Chapter 4, Water Resources). Changes in the water levels in the bedrock aquifers will be virtually the same with or without the proposed mine.

By 1990, the Gillette to Douglas rail line will be completed and carrying coal traffic from the basin's mines. Some highway construction and improvements are planned to accommodate increased traffic resulting from regional development. A new electric transmission line will also be constructed to serve regional coal mines.

By 1990, regional population is projected to increase 57%, from a 1978 level of 37,780 to 59,394. Most of the population growth is expected to occur in Campbell County, primarily in Gillette (Centaur 1978). There will be a corresponding increase in demand for housing and for community services, some finite and predictable (water, schools, fire protection), and others more difficult to assess (social services). It will be difficult for Gillette to accommodate such demands, since the population influx will precede the availability of increased revenue, and since some services and facilities are already inadequate. (The same problems can be expected in Douglas, or any other community which experiences rapid population growth.)

The effects of regional population growth will be felt beyond the urban areas: traffic will increase; there will be increased demand for recreation opportunities; the traditional agricultural way of life will change to reflect the attitudes of newcomers.

See Chapter 4, Socioeconomic Conditions and Recreation, for detailed analyses of the economic and social impacts of regional development.

CHAPTER 3

PLANNING AND ENVIRONMENTAL CONTROLS

INTRODUCTION

This chapter describes the planning and environmental controls which bear on coal development.

This chapter is in three parts: (1) a list of legislation and regulations which constrain federal, state, and/or local governments when they consider authorization of coal development; (2) a discussion of land use plans, controls, and constraints; and (3) a summary of federal, state, and local agency interrelationships.

LAWS, REGULATIONS, AND POLICY GUIDANCE

Coal Leasing

Two laws that provide the basic authorities for leasing federal coal are: Mineral Leasing Act of 1920 (41 Stat. 437, as amended; 30 U.S.C. 181 et seq.) and Mineral Leasing Act for Acquired Lands of 1947 (61 Stat. 913; 30 U.S.C. 351-359).

The law that provides the basis for public land and resource management is the Federal Land Policy and Management Act of 1976 (90 Stat. 2743; 43 U.S.C. 1701-1771).

These laws are implemented by the Bureau of Land Management (BLM) and the Geological Survey (GS) under the following regulations:

Title 43 CFR Part 3041 provides procedures to ensure that adequate measures are taken during exploration or surface mining of federal coal (among other minerals) to avoid, minimize, or correct damages to the environment (land, water, and air) and to avoid, minimize, or correct hazards to public health and safety.

Title 43 CFR Part 3500 provides procedures for leasing and subsequent management of federal coal (among other minerals) deposits.

Title 43 CFR Part 2800 establishes procedures for issuing rights-of-way to private individuals and/or companies on public lands.

The Federal Coal Leasing Amendments Act of 1975, which amended the Mineral Leasing Act of 1920, requires that a lease sale cannot occur until the lands to be leased are included in a comprehensive land use plan. The act also provides for the consolidation of leases into logical mining units, and for diligent development, operation, and production of the reserves in a logical mining unit. The act also set the minimum royalty rate at 12½% for surface-mined coal, permitted the Secretary of the Interior to set a lower rate for underground mined coal, and increased the state share of the royalty revenues from 37½% to 50%.

Coal Development (Mining)

Title 30 CFR Part 211 governs operations for discovery, testing, development, mining, and preparation of federal coal under leases, licenses, and permits pursuant to 43 CFR Part 3500. The purposes of the current regulations in Part 211 (May 1976) are to promote orderly and efficient operations and production practices without waste or avoidable loss of coal or other mineral-bearing formations; to encourage maximum recovery and use of coal resources; to promote operating practices which will avoid, minimize, or correct damage to the environment, including land, water and air, and avoid, minimize, or correct hazards to public health and safety; and to obtain a proper record of all coal produced.

Surface Mining Control and Reclamation Act of 1977 (SMCRA) (30 U.S.C. 1201) regulates the surface mining of all coal deposits and is implemented by the Office of Surface Mining under the regulations in Title 30 CFR Part 700. It is expected that the Secretary of the Interior will reach a decision on the Office of Surface Mining (OSM) permanent regulatory program by February 15, 1979. This program will provide a basis for state programs and result in some changes and modifications of requirements. Such changes should not affect the validity of this environmental statement, however. The permanent regulatory program does not include the federal lands program, which has not yet been promulgated. Many of these regulations are similar to the 43 CFR 3041 and 30 CFR 211 regulations which regulate coal development on federal lands. The new act and regulations provide for:

1. Environmental performance standards for surface coal mining and reclamation operations.
2. Inspection and enforcement procedures, including the assessment of civil penalties.
3. Requirements for state programs.
4. Requirements for the federal lands program.
5. Development of the initial regulatory program to be incorporated into coal mining permits issued under state law and the federal lands program.
6. Requirements and procedures for approval of state mining permits.

7. Requirements for posting, release, and forfeiture of reclamation performance bonds.

In all cases, pursuant to Section 515 of SMCRA and Title 30 CFR 715.13 (December 1977), coal mining operations will be required, as a minimum, to restore the lands affected to a condition capable of supporting the use which they supported prior to any mining, or higher or better uses of which there is reasonable likelihood. Mining permits will not be approved unless the applicant has demonstrated that reclamation to the proposed post-mining land use can be accomplished under a mining and reclamation plan.

In summary, surface protection and reclamation of lands mined for coal production is provided by various regulations enforced by the Department of the Interior (43 CFR 3041 and 30 CFR 700), as well as regulations enforced by the State of Wyoming (Land Quality Rules and Regulations). Surface protection and reclamation provisions are further covered under a cooperative agreement between the State of Wyoming and the Department of the Interior. The agreement provides for cooperation in review and approval of mining and reclamation plans, as well as cooperation in monitoring and enforcing reclamation standards.

Uranium

The Nuclear Regulatory Commission is responsible for issuing source material licenses (under 10 CFR 51) for the mining, processing, and use of nuclear materials such as uranium. The Wyoming Department of Environmental Quality (DEQ) also regulates uranium mining and milling activities as they relate to air, land, and water quality, and solid waste disposal.

Industrial Siting and Land Use Planning

The Wyoming Industrial Development Information and Siting Act of 1975 requires a siting permit for industrial development costing 50 million dollars or more in 1975 dollars. The act also requires a prospective industry to furnish plans for alleviating socioeconomic impacts and providing other extensive information before a state permit is granted for construction. Control does not apply to public properties except as provided by law. The first two projects to be sited under this act were the Jim Bridger Power Plant (Sweetwater County) and the Missouri Basin Power Plant near Wheatland, Wyoming. The Wyoming Industrial Siting Administration has responsibility for the issuance of siting permits.

The Wyoming Land Use Planning Act requires completion of county land use plans by 1978. These plans could conflict with or modify some energy development proposals.

Air Quality

Specific applicable legislation and regulations relating to air quality include:

1. Clean Air Act of 1970
2. National Ambient Air Quality Standards (NAAQS)
3. New Source Performance Standards
4. Wyoming Environmental Quality Act of 1973
5. Wyoming Ambient Air Quality Regulations
6. Clean Air Act amendments of 1977

The Clean Air Act of 1970 specified that each state would be responsible for ensuring the air quality within its borders and for specifying the way that quality would be achieved and maintained.

On April 30, 1971, the Environmental Protection Agency (EPA) officially announced the primary and secondary NAAQS (*Federal Register*, April 30, 1971). The primary standards were established to protect human health, whereas the secondary standards were established to protect the public welfare from any known or anticipated adverse effects. Standards were put into effect for suspended particulate matter, sulfur oxides, nitrogen oxides, photochemical oxidants, carbon monoxide, and hydrocarbons (see Table R3-1).

The Wyoming ambient air quality standards were put into effect in accordance with the Wyoming Environmental Quality Act. On January 22, 1972, the State of Wyoming adopted air quality regulations that were slightly more stringent with respect to total suspended particulates (TSP) and sulfur dioxide (SO_2) than the NAAQS regulations. Under Article 2 of the act, the Air Quality Division of DEQ is empowered to enforce these air quality standards (see Table R3-1).

The 1970 Clean Air Act also provided the authority to establish "emission standards"(new source performance standards) for new stationary sources and for existing sources in categories for which national standards of performance had been established.

The 1977 Clean Air Act Amendments contain major revisions of the 1970 act with respect to: (1) the setting of primary standard for nitrogen dioxide (NO_2); (2) the identification of regions within individual states that do or do not meet NAAQS; (3) the strengthening of enforcement mechanisms; (4) the establishment of regulations to control criteria pollutants in addition to suspended particulates, NO_2, and SO_2; and (5) the establishment of standards for stationary sources. The 1977 amendments to the Clean Air Act established "maximum allowable increases"which limit future increases of ambient concentrations of TSP and SO_2 above baseline concentrations. Ambient concentrations in calendar year 1974 are nominally the baseline concentrations. The "maximum allowable increases"(or increments) were established for three classes of areas as a function of the desired rise in ambient TSP and SO_2 concentrations. The air quality impacts of the emissions from all "major"stationary sources use up the prevention of significant air quality deterioration (PSD) increments shown in Table R3-2. The baseline concentrations plus the increments cannot exceed the national ambient air quality standards.

The maximum allowable increases (or increments) limit the amount of air pollutant-emitting development. Class I area increments allow very little increase in ambi-

TABLE R3-1

FEDERAL AND WYOMING AIR QUALITY STANDARDS

Pollutant	Averaging Time	Federal Primary Standards* $\mu g/m^3$	Federal Primary Standards* ppm	Federal Secondary Standards* $\mu g/m^3$	Federal Secondary Standards* ppm	Wyoming State Standards** $\mu g/m^3$	Wyoming State Standards** ppm
Sulfur Dioxide (SO_2)	Annual (Arithmetic)	80	.03			60	.02
	24-hour	365	.14			260	.10
	3-hour			1,300	.5	1,300	.5
Total Suspended Particulates (TSP)	Annual (Geometric)	75		60		60	
	24-hour	260		150		150	
Carbon Monoxide (CO)	8-hour	10,000	9	10,000	9	10,000	9
	1-hour	40,000	35	40,000	35	40,000	35
Photochemical Oxidant	1-hour	160	.08	160	.08	160	.08
Nonmethane Hydrocarbons***	3-hour (6-9 a.m.)	160	.24	160	.24	160	.24
Nitrogen Dioxide (NO_2)	Annual	100	.05	100	.05	100	.05

* Title 40 CFR Part 50, National Ambient Air Quality Standards. (Standards for averaging times of less than one year are not to be exceeded more than once a year.)

** Wyoming Ambient Air Quality Regulations, as amended in 1975. (Standards for averaging times of less than one year are not to be exceeded more than once a year.)

*** Standards set as a guide to achieve to photochemical oxidant standards.

TABLE R3-2

MAXIMUM ALLOWABLE INCREASES FOR SO_2 AND TSP FOR PREVENTION OF SIGNIFICANT AIR QUALITY DETERIORATION

Pollutant	Averaging Time	Maximum Allowable Increases ($\mu g/m^3$)		
		Class I	Class II	Class III
Sulfur Dioxide (SO_2)	Annual Mean	2	20	40
	24-hour*	8	91	182
	3-hour*	25	512	700
Total Suspended Particulates (TSP)	Annual Mean	5	19	37
	24-hour*	10	37	75

Source: 1977 Clean Air Act Amendments

Note: Under the 1977 Amendments to the Clean Air Act all areas are designated Class II except Mandatory Class I areas.

* The 3-hour and 24-hour SO_2 and 24-hour TSP concentrations can be exceeded not more than once per year.

ent TSP and SO_2 levels. Very little energy-related development is possible in Class I areas. Class II area increments were designed to allow a moderate increase in ambient TSP and SO_2 levels. Class III area increments were designed to allow the maximum increases in ambient TSP and SO_2 concentrations. The highest level of energy-related development is possible in Class III areas. Regulatory measures to prevent significant air quality deterioration for the other criteria pollutants are to be promulgated by EPA in 1979.

Under the 1977 amendments, all areas of the United States were designated Class II, except for "mandatory"-Class I areas. At present, there are no Class III designated areas. In mandatory Class I areas, visibility cannot be impaired nor can the increments be exceeded. No mandatory Class I areas are within the Eastern Powder River Basin. The nearest mandatory Class I areas are Grand Teton and Yellowstone national parks in the northwest corner of Wyoming about 200 miles west of the Eastern Powder River Basin, and the North Cheyenne Indian Reservation in southern Montana, located 80 miles northwest of Gillette. Devil's Tower National Monument, located about 40 miles northeast of Gillette, is presently being studied by the National Park Service for possible Class I status. Class II areas can be reclassified by the state; however, mandatory Class I areas cannot be reclassified.

Under the new PSD review procedure promulgated by the EPA on June 19, 1978, the impact of fugitive dust emissions from surface coal mines are not to be included in the air quality analyses for the PSD increments, nor for national ambient air quality standards. Fugitive dust has been defined by the EPA to be particles of native soil which are uncontaminated by pollutants resulting from industrial activity. Fugitive dust accounts for about 98% to 99% of all particulate emissions from strip mines. Particulate emissions from stationary sources (e.g., crusher) units of surface mines are typically less than 1% to 2% of the total emissions. Because the new PSD procedures were not implemented by EPA prior to the modeling effort, the regional air quality analyses has been prepared using the previous PSD regulations. The previous regulations require the air quality impact of all particulate emissions from a surface mine be analyzed for PSD review.

The EPA has indicated that each mine operator will have to employ the best management practice for fugitive dust control regardless of the predicted concentrations during operations. (EPA interprets best management practice as those procedures or techniques that can be reasonably used to control fugitive dust.) The proposed OSM permanent regulatory program includes a number of specific requirements (known as best available control technology or best management practice) to be followed, as appropriate, by surface mining operations to reduce fugitive dust levels. Thus, each mining plan and the Department of the Interior's approval thereof will stipulate an appropriate combination of the following fugitive dust controls.

1. Pavement or equivalent stabilization of all haul roads used or in place for more than 1 year.

2. Treatment with semipermanent dust supressants of all haul roads used or in place for less than 1 year and for more than 2 months.

3. Watering of all other roads in advance of and during use whenever sufficient unstabilized material is present to cause excessive fugitive dust.

4. Reduction of fugitive dust at all coal dump (truck to crusher) locations through use of negative pressure bag house or equivalent methods. Inclusion of conveyor and transfer point covering, and spraying, and the use of coal load-out silos.

All mining operations which have the potential to emit more than 250 tons per year of uncontrolled particulates will be required to apply for PSD permits.

Note that the Wyoming DEQ will determine on an individual mine basis the pollutant emission controls that will be required as part of their permitting process.

The 1977 amendments have been passed by the U.S. Congress and are, therefore, law. Specific regulations needed to fulfill the requirements of these amendments are being drafted by the responsible agencies. However, neither the federal agencies nor the states are relieved of the responsibility for meeting the requirements of the Clean Air Act Amendments of 1977.

Water Quality

Specific applicable legislation and regulations include:

1. Federal Water Pollution Control Act (FWPCA), as amended in 1972

2. Wyoming Environmental Quality Act of 1973

3. Water Quality Standards for Wyoming, Wyoming Department of Health and Social Services, June 28, 1973, superseded by Quality Standards for Wyoming Surface Waters, June 6, 1978

National standards to restore and maintain the chemical, physical, and biological integrity of the nation's waters were promulgated by the FWPCA.

The proposed OSM permanent regulatory program contains requirements as to water quality control in the mine permit area during development, mining, and reclamation. These requirements augment water quality protection provided by State of Wyoming and EPA regulations.

Wyoming water quality standards were issued in accordance with the Wyoming Environmental Quality Act of 1973. Under Article 3 of the act, DEQ's Water Quality Division is empowered to enforce these water quality standards. Important prescribed standards include those which specify maximum short-term and long-term concentrations of pollution, minimum permissible concentrations of dissolved oxygen and other matter, and the permissible temperatures of the waters of the state. Effluent standards and limitations specifying the maximum amounts of pollution and waste which may be discharged into state waters are described. Other health and water quality standards pursuant to Section 402(b) of the FWPCA are also described. Water quality standards are generally established on the basis of ultimate water use.

Thus, standards for municipal water will vary from those for agricultural water use.

Water quality planning required by Section 208 of the FWPCA is in progress in the region. Wyoming has identified Campbell County as falling within a "designated area"having priority planning needs for identification of management practices necessary to maintain or improve water quality. A major emphasis is nonpoint source pollution resulting from surface disturbance such as mining. As a "designated area,"Campbell County is included in a recently completed draft water quality plan prepared by a special planning agency, Powder River Area Planning Organization, with consultation with EPA. The draft plan is currently undergoing state certification review.

Converse County falls into the category of an "undesignated area"(one of twelve such counties in Wyoming). DEQ has contracted the preparation of a water quality plan for Converse County with the Wyoming Conservation Commission. The plan will be completed by 1983, as federal funds become available. Energy development impacts will be addressed in great detail.

The State of Wyoming is responsible for setting water quality standards and developing all "208 plans"; however, EPA plays a monitoring and arbitration role in the process.

Water Rights

Wyoming water laws state that priority of appropriation for beneficial use shall be given the better right, and in the order of preferred use that water for drinking purposes for both man and beast shall be first.

Wyoming laws, in part, also provide that whenever a well withdrawing water for beneficial purposes shall interfere unreasonably with an adequate well developed solely for domestic or stock use, the state engineer may, on complaint of the operator of the domestic or stock well, order the interfering appropriator to cease or reduce withdrawals of underground water, unless such appropriator furnish at his expense, sufficient water at the former place of use to meet the need for domestic and stock use.

The laws also provide that private property shall not be taken or damaged for public or private use without just compensation. A water right is private property.

Regulations pursuant to the Surface Mining Control and Reclamation Act provide that a coal mine permittee must replace the water supply of an owner of interest in real property who obtains his water from an underground or surface source, if coal mining operations have adversely affected that water supply.

Solid Waste Disposal

Applicable regulations include the Wyoming Solid Waste Management Rules and Regulations 1975, these provide for submission of solid waste disposal plans to the state by every person or municipality proposing such disposal.

Cultural Resources

Applicable authorities include:

1. Antiquities Act of 1906 (34 Stat. 225; 16 U.S.C. 431-433)
2. Historic Site Act of 1935 (49 Stat. 666)
3. Historic Preservation Act of 1966 (80 Stat. 915; 16 U.S.C. 470)
4. National Environmental Policy Act of 1969 (33 Stat. 852; 42 U.S.C. 4321, et seq.)
5. Reservoir Salvage Act of 1960 (74 Stat. 220)
6. Executive Order 11593
7. Federal Land Policy and Management Act of 1976 (96 Stat. 2743)
8. State laws as appropriate

Both federal and state antiquities acts regulate antiquities excavation and collections, and both protect historical values on public lands. They provide for fines and/or imprisonment for violators of their provisions. The Historic Preservation Act requires that certain federal undertakings be submitted for review to the National Advisory Council on Historic Preservation. Executive Order 11593 requires all federal agencies to cooperate with nonfederal agencies, groups, and individuals to insure that federal plans and programs contribute to the preservation and enhancement of nonfederally-owned historic and cultural values.

In Wyoming, no mining on, or rights-of-way across, public lands will be approved until BLM or the Forest Service (FS), after consultation with GS, has coordinated professional cultural resource surveys with the Wyoming State Historic Preservation Officer and has received his written comments and review. Additional surveys and mitigation may be necessary if surface evidence indicates further evaluation is necessary.

BLM and GS have developed procedures titled "Cooperative Procedures Between the U.S. Geological Survey and the Bureau of Land Management for Protection of Cultural Resources Related to Onshore Mineral Lease Operations Exclusive of Oil, Gas, Geothermal, and Oil Shale,"dated July 28, 1977. These procedures have been implemented for coal development within the region.

Water impoundments which would inundate important cultural values can be considered, pending decisions by the State Engineer. If a planned reservoir covers public land surface or mineral estate and its water is designated for another federally approved project, it will first be assessed under the requirements of the National Environmental Policy Act and the Reservoir Salvage Act. If cultural values are located, the "criteria for effect,"as explained in detail under Section 106 of the National Historic Preservation Act and Section 2(b) of Executive Order 11593 will be initiated by any federal agency joined in the project.

Paleontology

Paleontological resources are protected under authorities contained in the Federal Land Policy and Management Act of 1976.

Railroads

The Interstate Commerce Act (49 Stat. 543, 49 U.S.C. 1(18)) requires prior approval from the Interstate Commerce Commission for the extension or new construction of a line of railroad or the abandonment of operation of a line of railroad. Exempted from this authority are spur, industrial team, switching, or side tracks located wholly within one state. Commission certification is based on a balancing of the relevant economic, technical, and environmental factors.

Natural Gas Pipelines

The Natural Gas Act as amended requires that the Federal Energy Regulatory Commission approve comingling of synthetic natural gas (such as that produced in a coal gasification plant) with natural gas in the interstate pipeline system.

Mineral Protection

Oil and gas leases are in effect for much of the region. Priorities for mining or drilling for oil and gas on public lands are established by the Conservation Division of GS. Mining operations approaching wells or bore holes that may liberate oil, gas, water, or other fluid substances must be approved in accordance with 30 CFR 211.17 and 30 CFR 211.63. Impacts of mining on oil and gas areas can be mitigated largely by agreements among operators or by technical methods such as directional drilling, drainage practices, recovery of wells lost, pipeline and flow line relocation, and pillar recovery.

Vegetation and Wildlife

Applicable authorities include:

1. Endangered Species Act of 1973 (87 Stat. 844)
2. Bald Eagle Protection Act of 1969 (16 U.S.C. 668-668c)
3. Fish and Wildlife Coordination Act of 1958 (relates to projects on navigable streams)

The Endangered Species Act provides protection for listed species (both flora and fauna) and their critical habitat. Prior to authorization of any federal action, the Department of the Interior will require that a survey be made to determine if listed species or their habitat may be present. If it is determined that listed species or their habitat may be present and could be affected by the proposed activities, appropriate consultation with the U.S. Fish and Wildlife Service (USFWS) will be carried out. No activities will be authorized until consultation is completed as per 50 CFR 402 (January 4, 1978).

The Bald Eagle Protection Act of 1969 prohibits molestation of eagles and their nests. Recent amendments to the act authorized the Secretary of the Interior to issue regulations to permit the taking of golden eagle nests which interfere with resource development or recovery operations.

The Fish and Wildlife Coordination Act of 1958 provides that USFWS will be consulted on matters which could affect navigable waters and/or any fish or wildlife resource.

Floodplains Management

Executive Order 11988, May 24, 1977, directs federal agencies to take appropriate actions to avoid, to the extent possible, long- and short-term adverse impacts associated with the occupancy and modification of floodplains. The executive order further states that federal agencies will avoid direct or indirect support of floodplain development wherever there is a practicable alternative.

Protection of Wetlands

Executive Order 11990, May 24, 1977, directs federal agencies to take appropriate actions to avoid, to the extent possible, long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative.

Provisions For Revenue Sharing And Taxation

The state government provides several methods of offset energy development impacts: (1) the infusion of additional revenues to local units of government, (2) the provision of information and technical assistance, and (3) the introduction of state and local influence into the siting of energy facilities. Efforts to increase local revenues have included automatic increases in the distribution of state tax receipts, legislated increases in the distribution of the sales tax, joint powers loans, coal impact tax grants, and the enactment of an optional sales tax. The state has tried to provide information and technical assistance to local governments through the Department of Economic Planning and Development and the Industrial Development Information and Siting Act.

Local Sales Tax

Cities and counties have the option to impose a 1% sales tax.

Mineral Leasing Royalties

The state receives 50% of the mineral royalties from any mineral leasing projects as provided by the Federal Coal Leasing Amendments Act of 1975. The state divides its share as follows: municipalities 7.5%, counties 2.25%, state highway work in counties affected by resource development (2.25%), the school foundation program (37.50%), the state highway fund (26.25%), capital outlays for higher education (6.75%), public schools capital construction (4%), and other (13.5%).

Severance Taxes

The state receives from operating coal companies 10.1% of the value of gross products extracted from mines. This 10.1% is allocated for the state general fund (2%), the permanent trust fund (2.5%), the water development account (1.5%), a capital facilities revenue fund (1.5%), the state highway fund (1%), and the coal impact fund (1.6%). The proceeds to the coal impact fund will increase to 2.0% in 1979, bringing the total severance tax on coal to 10.5%.

Coal Impact Tax. The state is using its option to tax coal mining companies to furnish a source of revenue to be spent for roads, streets, highways, water, and sewer projects. Limited funds accrued from the coal impact tax may be borrowed by local governments to upgrade certain public facilities.

Ad Valorem Revenues

Property taxes of 3.25 mills are presently collected in Campbell County for the state school equalization fund. Because of its high assessed valuation per pupil, Campbell County School District No. 1 does not receive state school equalization funds. The equalization levy is determined annually by the state and can vary from 0 to 6 mills.

Joint Powers Act

This act allows cities and counties to share revenues, facilities, and services.

LAND USE PLANS, CONTROLS, AND CONSTRAINTS

Land Use Controls

Federal

In the region of analysis, a large number of separate jurisdictional entities exercise certain types of land and resource use controls. The federal sector includes the FS (Thunder Basin National Grasslands) and BLM (public lands and subsurface estate under certain private lands).

Development, management, use, and control of use on public lands has been principally delegated to FS and BLM. Controls are effected through issuance or nonissuance of a variety of leases, permits, licenses, etc. Each authorization to use public lands contains provisions to control that use. Controls exercised by the federal government for the subsurface estate are governed by the statutes authorizing the disposition and use of that estate. Foremost among these statutes is the authority for leasing coal deposits and authority to require, as a condition of such leases, an operation-management plan and a reclamation-restoration plan. Management policy has been extended in greater detail by the National Environmental Policy Act of 1969 and the Federal Land Policy and Management Act of 1976.

In certain situations, there is a joint or multiagency sharing of particular management and control and responsibilities, such as the cooperative agreement between the Department of the Interior and the State of Wyoming for administering and enforcing reclamation operations on federal coal leases in Wyoming. The subsurface estate vested in private or state ownership would normally be governed by applicable State of Wyoming statutes.

State

The Wyoming Commissioner of Public Lands is responsible for the administration, leasing, and management of lands owned by the State of Wyoming. Under State of Wyoming statutes, the state is authorized to perform and administer certain surface land use, planning, and development activities on state, county, municipal, and privately-owned properties. Legislation which has a significant effect on land use are the Wyoming Environmental Quality Act, Wyoming State Land Use Planning Act, and the Industrial Development Information and Siting Act.

The State of Wyoming retains jurisdiction over state lands. Some of these lands were conveyed to the state as part of the act admitting Wyoming to the Union. This legislation granted Sections 16 and 36 of every township to the state for educational purposes. Use and control of these lands (including mineral leasing, rights-of-way, etc.) are governed by Wyoming law.

County

Both Campbell and Converse counties have full time planning staffs, and are developing comprehensive county plans. Under Wyoming statutes, counties have authority to effect a wide variety of controls on state-owned lands in matters not specifically reserved to the state. The authority applies only to those portions of the county that are unincorporated. A county may regulate and restrict location and use of buildings and structures, and use, condition of use, or occupancy of lands for residency, recreation, agriculture, industry, commerce, public use, and other purposes. The authority does not apply to any planning or zoning controls over lands used

or occupied for the extraction or production of minerals unless reasonably necessary to protect the public good of its citizens.

Less than 1% of the land in the region is actually owned by county governments. Use and control of these lands are governed by state law and county ordinances. Control over mineral uses on these lands is vested in the State of Wyoming under the Wyoming Environmental Quality Act of 1973. This act also authorizes the state to control air quality, water quality, and solid waste management.

Municipal

Three incorporated towns or cities lie within the region. These are Gillette, Douglas, and Glenrock. Municipalities have authority to effect master plans, zoning, and other regulatory controls. The Wyoming Environmental Quality Act of 1973 preempts cities' authority to regulate and control air, water, solid waste, and land quality standards except where specifically delegated to municipalities.

Where a county or city lacks a specific authority, provisions of the Wyoming Joint Powers Act are available to enable joint exercise of power, privilege, or authority. This legislation enables two or more agencies to jointly plan, create, finance, and operate (control) water, sewage, solid waste, fire protection, transportation, and public school facilities.

Land Use Plans

Bureau of Land Management Planning

The Eastern Powder River Basin Management Framework Plan (MFP) was revised in 1977. The revised MFP is designed to serve as a guide for multiple-use management and development of the surface of public lands as well as the federal mineral estate, much of which lies under privately owned surface. The MFP area was selected to correspond with the region analyzed in 1974 (FES 74-55) and in this document. Proposals for coal development and lands of possible interest to the mining industry for potential coal development were addressed in BLM's land use planning process. Environmental costs and tradeoffs are considered in the MFP. An important aspect of the process included consultation with representatives of state government and local governments of Gillette and Douglas. Comments and suggestions received at public meetings also influenced the content of the 1977 revised MFP.

Potential socioeconomic impacts which could result from coal development are a major concern in the region. Some local and state government planners and many citizens have recommended a "go slow"approach when considering possible future coal development in the region. Since other interests, such as the coal industry, have recommended increased development, the 1977 revised MFP attempted to strike a balance between the recommendations and considered possible development in the vicinity of the new community of Wright in an effort to help reduce impacts to Gillette and Douglas.

Other recommendations and decisions of the MFP relating to coal are as follows:

1. To manage mineral resources for efficient development, giving priority consideration to energy minerals, but at the same time, providing environmental protection and consideration of socioeconomic impacts.
2. To designate areas of potential interest for coal development which are compatible for mining under the multiple-use concept of management, and which contain uncommitted and economic coal reserves that could be developed in conjunction with certain existing operations or mining plan proposals.
3. If the results of the current regional analysis are favorable, the approval of the mining and reclamation plan for the proposed Buckskin Mine would be in accordance with multiple use objectives of the MFP.
4. Future proposed actions in support of coal mining proposals (e.g., rights-of-way) would require analyses of possible impacts. If compatible with other uses of the area and accompanied by necessary environmental stipulations, such actions would serve the multiple-use objectives of the MFP.
5. New energy transmission or transportation facilities must be located within existing corridors wherever possible.

Any future planning surrounding the possibilities of lease phasing, scheduling, or exchange (not addressed in 1977 MFP) could be accomplished only through full involvement of state and local governments' assistance and recommendations.

Forest Service Planning

A portion of Thunder Basin National Grasslands is included within the region. A multiple use plan (MUP) covering this area was updated in December 1971. It establishes overall land use objectives for the grasslands and is the basis for all actions within the grasslands. The overall objectives on the grasslands emanate from the Multiple-Use Sustained-Yield Act of 1960, the Forest and Rangeland Resources Planning Act of 1974, and the National Forest Management Act of 1976.

Two types of federal surface estate are found on the grasslands: acquired lands and public domain lands. Acquired lands were obtained from private ownership, while public domain lands have always been in public ownership. Both of these surface estates are subject to the above acts. The MUP makes both types of lands available for coal leasing subject to certain constraints and direction established by FS. The constraints and direction relate to such issues as maintaining crucial wildlife habitat, maintaining the stability of critical ecosystems, evaluating the reclamation potential of lands to be leased, and weighing of environmental costs and sensitivities.

FS and BLM personnel met during BLM's MFP land use planning process in order to coordinate and prioritize possible future leasing areas within the grasslands.

Local Planning

In 1968, a joint Gillette/Campbell County Planning Department was formed; it currently employs three planners. The anticipated impacts of new coal mining have had priority consideration since January 1975. The Gillette/Campbell County Planning Department completed a preliminary draft planning program during June 1977. The final comprehensive plan was adopted by both the city and the county in July 1978. Two provisions of the plan which were written as a result of the coal mining near Gillette are as follows: (1) Local government should continue to monitor environmental quality within the limits of "in house"technical constraints. Environmental quality data and analysis should be obtained from public and private sources as it is made available. Sources of such information are encouraged to provide current data. (2) Buffer areas and "transition land uses"may be required between residential areas and new industrial and major commercial developments and between other incompatible land uses. A copy of the approved plan is on file at the BLM Casper District Office.

The Douglas/Converse County Area Planning Office (established in December 1974, and employing two planners in Douglas) serves the municipalities of Douglas, Glenrock, and the balance of Converse County. A comprehensive plan for Douglas, which includes a 3-mile peripheral area, was adopted by the town of Douglas and Converse County in May 1976. A similar plan for Glenrock (including a 2-mile peripheral area) is presently in the draft and review stage; it will be placed before the Converse County Commissioners and the Glenrock Town Council for consideration in the near future.

Peripheral areas ("buffer zones") proposed to surround the above towns would require any commercial or industrial development (except mining) to adhere to the respective land use plans.

Comprehensive local planning will be incorporated into federal land use plans (FS and BLM) as these plans are revised and updated.

INSTITUTIONAL RELATIONSHIPS

Federal

Office of Surface Mining (OSM)

OSM, in consultation with the surface-management agency (BLM or FS), GS, and the state regulatory authority, where applicable, recommends approval or denial of surface coal mining applications (including mining and reclamation plans) to the Assistant Secretary of Energy and Minerals. OSM is the federal regulatory authority responsible for reviewing coal mining permit applications; for enforcement of all environmental protection and reclamation standards included in an approved mining permit; for monitoring of both on and off-site effects of the mining operation; and for monitoring abandonment operations within the area of operation of a federal lease.

OSM is the principal contact for all coal mining activities within the area of operation. OSM will conduct as many inspections as are deemed necessary but no less than one partial inspection quarterly and at least one complete inspection every 6 months (30 CFR 721.11(c)) (December 1977).

OSM, after consultation with BLM or FS, GS, and the operator, establishes the boundaries of the permit area for the proposed mine and approves the locations of all the mine facilities located within this boundary.

Section 523 of SMCRA requires the federal program for surface coal mining regulation to adopt those state performance standards which the Secretary determines are more stringent than the federal standards. Therefore, the performance standards enforced by OSM on a federal leasehold should be at least as stringent as those required under state law or regulations.

The Department of the Interior negotiated a cooperative agreement pursuant to Section 523(c) of SMCRA with the State of Wyoming. This agreement was signed in October 1978. The OSM functions and responsibilities specified in the agreement have been delegated to the state regulatory authority. Under this agreement, OSM and the state regulatory authority will jointly review and act on mining permit applications and recommend approval or disapproval to the officials authorized to take final action on the application. The Secretary is prohibited by law from delegating his authority to approve mining plans on federal lands.

Bureau of Land Management (BLM)

BLM, after consultation with OSM, GS, the public, and the governor, may offer for competitive lease tracts of lands found potentially valuable for development of coal. This is part of the land use planning process.

BLM formulates special requirements to be included in a lease or mining permit application concerning the management and protection of all resources other than coal and the postmining land use of affected lands.

BLM, after consultation with GS and OSM, is responsible for the authorization of various ancillary facilities such as access roads, power lines, communication lines, and railroad spurs proposed by a mining company on federal lands outside the permit area. Rights-of-way can only be granted pursuant to Title V of the Federal Land Policy and Management Act of 1976. Rights-of-way are approved subject to standard requirements for duration of the grants, right-of-way widths, fees or costs, and bonding to secure obligations imposed by the terms and condtions of the grants. The terms and conditions applicable to rights-of-way are determined by the regulations found in 43 CFR 2800, by the BLM land use plan, and by on-the-ground evaluations.

BLM is the lead agency, in coordination with GS and OSM, for all proposed uses other than coal mining on federal lands within a leasehold.

Geological Survey (GS)

GS is responsible for reviewing mining plans for development, production, and coal resource recovery requirements on federal leaseholds. GS is responsible for assuring the maximum economic recovery of the federal coal resource and that the federal government receives fair market value for the coal resource.

Forest Service

FS manages the national forests and grasslands under the principles of the Multiple-Use Sustained-Yield Act of 1960 (74 Stat. 2.5, 16 U.S.C. 528-531). Rights-of-way on acquired lands in the national grasslands are granted under authority of the Bankhead-Jones Farm Tenant Act (50 Stat. 525; 7 U.S.C. 1010-1013) and the Federal Land Policy and Management Act of October 21, 1976.

Historically, lands managed by FS have been subject to mineral exploration and mining. Coal leasing development is subject to applicable laws and regulations and constraints developed in multiple-use planning.

A surface mining operation must reclaim the surface sufficiently to achieve a land configuration consistent with the purpose of the Bankhead-Jones Act and the current land use plan for the affected area.

Relationship and Special Requirements of the Federal Land Policy and Management Act, Federal Coal Leasing Amendments Act, and the Surface Mining Control and Reclamation Act (SMCRA)

The Federal Land Policy and Management Act requires development of a comprehensive land use plan prior to lease issuance. The plan must consider all resources and present and future land uses before land use allocations can be determined. Land uses on adjacent lands must also be considered prior to determination of postmining land use.

The Federal Coal Leasing Amendments Act requires that a comprehensive land use plan must be completed prior to lease issuance and that the proposed lease must be compatible with the plan. This act list specific areas which must be classified as unsuitable for surface mining.

Section 523 of SMCRA requires that a federal lands program which includes the requirements of this act be promulgated and implemented no later than August 3, 1978. Until the federal lands program is implemented, the initial regulations as required in Section 502 of SMCRA and published in final form (30 CFR 715 and 716) in the *Federal Register*, December 13, 1977, will apply, as modified, to all federal coal leases. These regulations will be modified under the authority of Sections 523(c) and 702(b) of this act to meet the requirements of the Federal Coal Leasing Amendments Act of 1975 (30 U.S.C. 181 et seq.) and the Federal Lands Policy and Management Act of 1976. The basic changes in the regulations will be that: (1) postmining land use cited in the reclamation plan will be that which is part of the surface-management agency's comprehensive land use plan; (2) permanent roads, dams, power lines, etc., to be constructed on public lands will meet the design standards of the surface managing agency; and (3) resource data collected in the process of developing the land use plan or lease stipulations will be available for use in developing the reclamation plan.

The following is a discussion of the relationship among specific requirements of the three laws. The specific sections below serve as mitigatory measures. Regulations cited below were published in final form in December 1977.

Surface Owner Consent. Pursuant to Section 714 of SMCRA, where coal owned by the United States falls under private surface, the Secretary of the Interior shall not enter into any lease until the surface owner has given written consent to enter and commence a surface mining operation.

Alluvial Valley Floors West of the 100th Meridian, and Prime Farmland. Soils, geomorphic, biological, and land use information will be utilized to inventory lands to determine whether they should be classified as alluvial valley floors and prime farmland. A mining and reclamation plan which proposes to conduct a surface coal mining operation on or adjacent to alluvial valley floors shall include baseline data and surveys as prescribed in 30 CFR 715.17(j) to establish standards which ensure the preservation of the hydrologic function of these alluvial valley floors. Prior to approval to mine on lands classified as prime farmlands, the operator will have to provide data to demonstrate that his proposed method of reclamation will achieve, within a reasonable time, equivalent or higher levels of yield after mining as existed before mining. If approved, special soils handling and storage stipulations will be included in the mining plan.

Lands Classified as Unsuitable for Surface Coal Mining. Lands proposed for surface mining, as well as lands included in petition applications requesting the designation of coal lands as unsuitable for surface coal mining will be processed through the surface-management agency's land use planning and public involvement procedures. Petition applications should be filed with OSM. Prior to designating lands unsuitable for mining, except those specific tracts of land described in Section 522(e) of SMCRA, the surface-management agency shall prepare a statement on: (1) the potential coal resources of the area; (2) the demand for the coal resources; and (3) the impact of such a designation on the environment, the economy, and the supply of coal. The Federal Land Policy and Management Act also provides for classification of "Areas of Critical Environmental Concern"

Unsuitability Criteria. Once the proposed unsuitability criteria published in the *Federal Register* (December 8, 1978) become final, they will be applied to all lands included in any application for a federal mining and reclamation plan permit. Federal coal lands meeting the unsuitability criteria can be classified as unsuitable for surface mining.

Archeological Historical Sites and Endangered and/or Threatened Species. Inventories will be conducted on

lands to be impacted by the surface-management agency, and stipulations necessary for the management and protection of these resources will be included in the mining permit.

Federal Lessee Protection. Prior to approval of a mining and reclamation plan, the surface of the public lands will be inventoried for legally installed appurtenances. Agreements with the federal lessee will be reached or bonds will be obtained to ensure that the lessee's investments are protected.

Reclaimability to Present Use. Prior to approval of a mining and reclamation plan, it must be demonstrated that the land can be reclaimed to its premining productive capability. Where the determination is made that certain lands cannot be reclaimed to the approved postmining land use, surface mining will not be permitted.

Performance Bonds. Surety bonds are required at the time of lease issuance and may be adjusted prior to approval of the reclamation plan. Minimum surety for reclamation is set by SMCRA at $10,000. In addition, a surety bond will be required to ensure payment to the government for each ton of coal mined.

Use of Explosives. The requirements of 30 CFR 748 will be included as part of any mining and reclamation plan submitted for approval.

Water Rights. The area around the proposed mining area will be inventoried for water uses and water rights. Special requirements will be included in the mining and reclamation plan to protect the water rights of others.

Revegetation. To ensure that the proposed reclamation plan is being developed to meet the objectives of the postmining land use, the composition and density of plants necessary to meet those objectives will be listed in the mining permit application. The surface-management agency will inspect leases and permit areas for compliance with terms, conditions, and stipulations relating to the management and protection of federal lands and resources and postmining land use.

Impoundments. The regulations provide standards and requirements for dams constructed of or impounding waste material. Requirements are also established in the regulations for permanent impoundments.

Public Health and Safety. The authorized representative of OSM has the authority to enter and inspect for compliance with the initial performance standards in 30 CFR 715 and 716. He has the authority to order a cessation of mining or reclamation operations if, in the course of an inspection or investigation, he finds conditions, practices, or violations of the initial performance standards which create an imminent danger to the public health and safety, or conditions or practices which can be expected to cause significant environmental harm.

The Public. Any person who is or may be adversely affected by a surface mining operation may notify the Regional Director of OSM (or his representative responsible for conducting inspections) in writing of any violation of SMCRA which he has reason to believe exists at the surface mine site.

State and County

State of Wyoming

DEQ. The Department of the Interior has negotiated a cooperative agreement with the State of Wyoming pursuant to Section 523(c) of SMCRA. It was signed in October 1978. Since this agreement has been consummated with the state, the OSM functions and responsibilities specified in the agreement has been delegated to the state regulatory authority (DEQ). Under this agreement, OSM and DEQ will jointly review and act on mining permit application and recommend approval or disapproval to the officials authorized to take final action on the plans. The Secretary is prohibited by law from delegating his authority to approve a mining plan on federal lands. Under the terms of the cooperative agreement, DEQ will serve as the authorized representative of OSM in inspection and enforcement of the reclamation provisions of a mining permit.

DEQ has authority relating to air quality, solid wastes, water quality, mining, and mined-land reclamation. Standards for reclamation are determined by DEQ on an individual mine basis, after evaluation of the project and its location. The Land Quality Division issues permits and licenses to mine according to the approved mining and reclamation plans. The Air Quality Division issues permits to construct and operate coal mines after approval of plans for monitoring and controlling air contaminants. The Water Quality Division issues permits to construct settling ponds and waste water systems. They also issue National Pollutant Discharge Elimination System permits for discharging waste water. The Solid Waste Division issues construction fill permits and industrial waste facility permits for solid waste disposal during construction and operation of a coal mine.

Commissioner of Public Lands. Utility lines, roads, and railroad spurs crossing state land require easements from the Commissioner of Public Lands.

Wyoming Highway Department. Relocation of highways and all utility line crossings of state and federal aid highways require authorizations from the Wyoming Highway Department.

Wyoming State Engineer. Use of surface or groundwater for mining and coal processing operations requires a permit from the State Engineer. Water pipelines also require permits from the State Engineer.

Relationships With Private Interests

Interaction between private and federal property interests occurs frequently in the Eastern Powder River Basin, resulting from the historical federal practice of conveying land to private ownership with reservation to the United States of some or all minerals underlying the land. As a result, although 75% to 80% of the land surface is privately owned, 75% to 85% of the mineral rights are retained by the federal government (see Table R3-3). The acts of June 22, 1910 (30 U.S.C. 83-85) and

TABLE R3-3

SURFACE AND MINERAL OWNERSHIP
EASTERN POWDER RIVER BASIN

Campbell County (3,034,614 acres)

Surface Ownership

Private	80.2%
State	7.2%
Federal	12.6%
	100.0%

Mineral Ownership

Private and State	∿15%
Federal	∿85%
	100%

Converse County (943,946 acres)

Surface Ownership

Private	75.3%
State	12.8%
Federal	11.7%
County	.9%
	100.0%

Mineral Ownership

Private and State	∿25%
Federal	∿75%
	100%

July 17, 1914 (30 U.S.C. 121-124) were the earliest federal statutes calling for this reservation. The reservations required by those acts were limited to specific minerals, most commonly oil and gas or coal.

In the case of reservation of coal, the act of June 22, 1910 provides that any person having rights to prospect for or mine the coal may enter and occupy the land for that purpose. He must first pay the surface owner for damages caused by his operation or post a bond to cover those damages.

By far the most common reservation of minerals occurs with lands which passed to private ownership under the Stockraising Homestead Act of December 29, 1916 (39 Stat. 862; 43 U.S.C. 291-302). Section 9 of that act provides that all conveyances of land under its provisions shall contain a reservation to the United States of all minerals, together with the right to prospect for, mine, and remove them. In addition, the law spells out in some detail the relative rights of the surface owner and the holder of mineral rights. Again, there is provision for posting of bond by the holder of any mineral rights (lease) for the benefit of the surface owner if agreement with the surface owner cannot be reached. Liability of the holder of mineral rights is limited to damage to crops (including forage) or other tangible improvements. Damages for reduction in the value of land for grazing can be awarded pursuant to the act of June 21, 1949 (63 Stat. 215; 30 U.S.C. 54).

Bonds posted under the above acts are filed with the BLM. If amounts of the bonds are protested as inadequate by the landowner, BLM must decide the proper amount.

In recent years, BLM has further concerned itself with protecting interests of surface landowners when it proposes to issue new coal leases. Protection of facilities critical to ranching operations is of particular concern. BLM consults with the landowners when preparing stipulations for inclusion in coal leases. BLM field offices make similar contacts with landowners when reviewing lessees' proposed mining plans which are submitted to BLM by GS for comment and recommendations. (Surface owner consent for mining is now also required by SMCRA.)

The Wyoming Environmental Quality Act also contains provisions to protect interests of a surface landowner where the surface and mineral estates are split. In such instances, a mining permit may not be issued without consent of the surface owner or the posting of a bond for the surface owner's benefit to secure payment of any damages "to the surface estate, to the crops and forage, or to the tangible improvements"of the landowner. Under both federal and state laws, if the extent of compensable damages cannot be agreed on by the parties, the landowner must sue for damages in court.

Private interests do not have any legal control over location of railroads or other public utility facilities in Wyoming; such utilities are authorized by state law to condemn lands where needed for their purposes, subject only to payment of compensation for the market value of the taking.

CHAPTER 4

ENVIRONMENTAL IMPACTS OF REGIONAL DEVELOPMENT

INTRODUCTION

This chapter discusses the impacts that would result from all expected developments in the region through 1990, including those related to coal, to other minerals, and to urban expansion. Cumulative regional development includes the proposed Buckskin Mine, which is the site-specific action under consideration in this environmental statement. For specific impacts of the Buckskin Mine, the reader is referred to the site-specific portion of this environmental statement.

The impact analysis which follows updates that in the previous Regional Environmental Statement (FES 74-55).

CLIMATE

The redistribution of soils and other materials at the mines, railroad, and transmission lines proposed for the region may cause small changes in the local climate. The modification of surface contours and albedo may cause local changes in wind speeds and directions, temperatures, and relative humidities. Any change in the number of thunderstorms caused by the lack of vegetation at the active mining areas would be localized.

AIR QUALITY

Introduction

Air quality impacts caused by coal developments and related activities in the Eastern Powder River Basin are addressed assuming a normal (or average) level of pollution control. These controls include a normal precipitation pattern over the region as well as no new coal fires. Any existing fires may contribute to ambient concentrations of total suspended particulates (TSP), but they are already included in the baseline TSP concentrations.

The impacts of all activities in the region are assessed for 1980, 1985, and 1990. The pollutant concentrations are compared to the national and Wyoming ambient air quality standards.

Emissions

Air quality modeling requires as inputs the pollutant emissions for each source modeled. Emissions were estimated for six different types of sources—surface coal mines, uranium mines and mills, coal-fired power plants, a coal gasification plant, towns, and transportation. (See Map 1, Appendix A for locations of these sources.)

Coal mines would be major contributors of particulate emissions in the region. Fugitive dust emissions would result from a number of activities within the mines, including blasting, coal and overburden loading and dumping, haul road and access road traffic, and wind erosion of exposed areas. For these operations, emission factors from the documents prepared by PEDCo Environmental, Inc. (1978a), the Wyoming Department of Environmental Quality (1976), and Cowherd et al. (1974) were used to relate the level of activity of an operation to fugitive dust emissions. Mines that are required to be reviewed by the Environmental Protection Agency for prevention of significant air quality deterioration will apply best management practices to control fugtive dust emissions. Operating information was extracted from individual mining and reclamation plans on file with the Area Mining Supervisor, Geological Survey. The annual emissions of particulates from regional coal development for 1980, 1985, and 1990 are shown in Table R4-1.

The uranium mills and mines also generate significant amounts of fugitive dust. The major sources of fugitive dust from the uranium mines include mining operations, access roads, ore crushing and screening, conveying, and handling. Emissions were estimated using emission factors similar to those for coal mining. The annual particulate emissions from the uranium mines and mills for the study years are also listed in Table R4-1.

Since the air quality modeling occurred in March 1978, a number of additional uranium mines have been proposed. Instead of four, five, and six mines, the number of mines has increased to six, twelve, and twelve for the years 1980, 1985, and 1990, respectively.

Table R4-1 lists the emission sources that were included in the modeling analysis, and the results are reflected in Figures R4-1, R4-2, and R4-3. The table and figures have been left unchanged to protect the integrity of the modeling effort. Table R1-3 shows the most recent projected uranium development for 1980, 1985, and 1990.

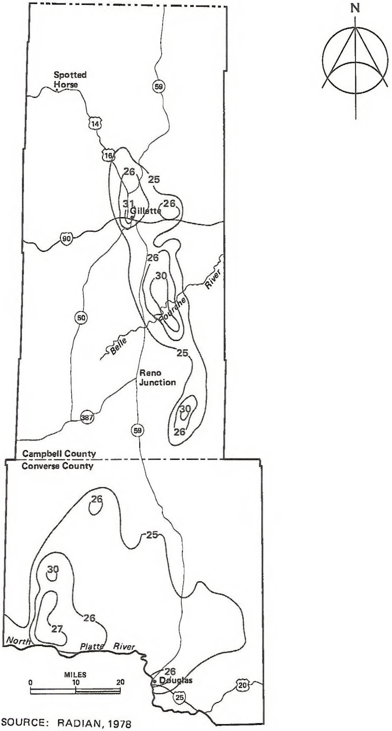
Based on the most recent information, most of the increased impact will occur in the vicinity of the Pumpkin Buttes in southwestern Campbell County. At present, the

TABLE R4-1

PARTICULATE EMISSIONS (TONS/YEAR) FROM REGIONAL MINING

Mine	Year		
	1980	1985	1990
Coal Mines			
Buckskin	763	1,176	1,276
Rawhide	1,596	2,026	2,218
Eagle Butte	2,077	3,222	3,096
East Gillette	1,670	1,531	1,492
Kerr McGee #16	765	1,200	1,240
Wyodak	406	434	682
Caballo	606	1,598	3,651
Belle Ayr	5,024	4,289	4,520
Pronghorn	801	1,628	1,769
Cordero	10,448	9,241	9,241
Coal Creek	1,481	3,432	3,432
Jacobs Ranch	2,431	2,754	3,149
Black Thunder	3,717	4,743	3,744
Dave Johnston	1,356	1,068	961
Rochelle	0	2,428	2,318
Uranium Mines			
Highland	1,763	2,655	3,425
Bear Creek	854	890	885
Morton	883	1,635	1,770
Bill Smith	854	910	910
Potential Mine		855	890
Potential Mine			855

Note: These sources of emissions were included in the modeling analysis (Figures R4-1, R4-2, and R4-3) but do not reflect the full extent of uranium development projected for 1980, 1985, and 1990. Table R1-3 shows the most recent projected uranium development for 1980, 1985, and 1990.



SOURCE: RADIAN, 1978

Figure R4-1

PREDICTED AMBIENT TSP CONCENTRATIONS ($\mu g/m^3$) FOR THE PROBABLE LEVEL OF DEVELOPMENT IN 1980

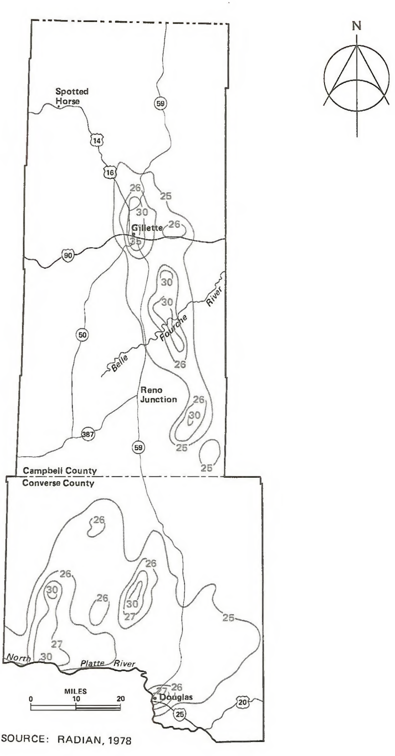


Figure R4-2

PREOICTEO AMBIENT TSP CONCENTRATIONS ($\mu g/m^3$)
FOR THE PROBABLE LEVEL OF OEVELOPMENT IN 1985

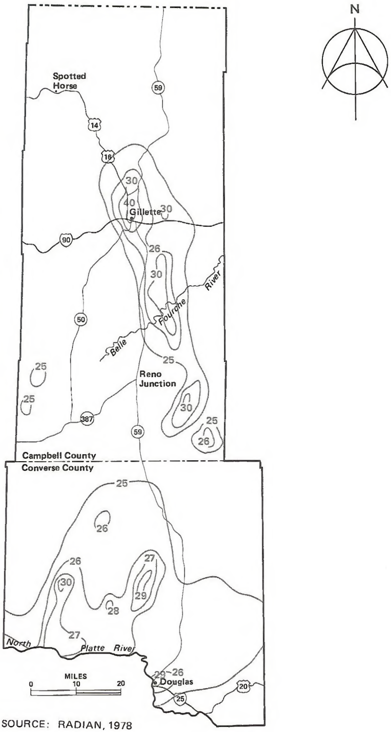


Figure R4-3
PREDICTED AMBIENT TSP CONCENTRATIONS ($\mu g/m^3$) FOR THE PROBABLE LEVEL OF DEVELOPMENT IN 1990

area is not industrially impacted so all increases would result from uranium development.

Small amounts of hydrocarbon, carbon monoxide, and oxides of nitrogen are released from vehicles, steam generators, and other combustion sources within coal and uranium mines. Because of the small quantities emitted, the effects on surrounding air quality are expected to be insignificant (U.S. Department of Interior 1976b).

Panhandle Eastern's gasification plant and the Dave Johnston and Wyodak power plants would all emit particulates, and oxides of sulfur and nitrogen (SO_x and NO_x). Predicted emissions for the gasification plant were taken from its environmental report on file at the Bureau of Land Management district office in Casper (SERNCO 1974). Emissions from the Wyodak coal-fired power plant were taken from the file kept by the Wyoming Department of Environmental Quality (Wyoming Department of Environmental Quality 1978). Pacific Power and Light Company, owners of the Dave Johnston Power Plant, provided the emission and stack parameters for their plant (personal communication, Horace Sanders 1978). The emissions for the Dave Johnston and Wyodak power plants and the coal gasification plant are listed in Table R4-2.

The five urban areas—Gillette, Moorcroft, Douglas, Glenrock, and Casper—are anticipated to have a significant effect on regional air quality for TSP, sulfur dioxide (SO_2), and nitrogen dioxide (NO_2). Current emissions for these pollutants were taken from the National Emissions Data System Inventory for 1977 (U.S. Environmental Protection Agency 1977). The total pollutant emissions of Campbell, Converse, Natrona, and Crook counties were apportioned to the five urban areas based on the percentage of the county population in each urban area. The 1980, 1985, and 1990 emissions from the urban areas were forecasted to increase in direct proportion to projected growth of the populations of the urban areas between 1978 and 1990. The population projections for the five urban areas are shown in Table R4-3. The TSP, SO_2, and NO_2 emissions from the urban areas are listed in Table R4-2.

The projected emissions listed in Table R4-2 are based on the projected population increases given in Table R4-3. Since the air quality analysis was made using these data, the population increases projected for the region have been revised upward. The air quality analysis does not reflect the revised data for population.

The air quality impact of vehicle emissions (exhaust and fugitive dust) in rural areas would be highly variable, intermittent, and generally confined to the immediate vicinity of the roads. Hence, the vehicular emissions were not included in the dispersion modeling.

Oil and gas activity is expected to increase by less than 3% above existing levels by 1990 in the region. Hence, significant change in the air quality impact of oil and gas production is not expected during the study period.

Other developments in the region include construction of transmission and railroad lines. A 59-mile transmission line south from the Wyodak Power Plant and a 28-mile transmission line north from the Dave Johnston Power Plant are to be constructed to meet near the Converse-Campbell county line. Construction of these transmission lines should be short term and have a minor impact on TSP concentrations in the region. Several railroad lines are to be constructed, including the 113-mile main line between Gillette and Douglas, a 40-mile private line for transportation of coal to the planned gasification plant, and several rail spurs and sidings to serve developing mining areas. During construction, small, temporary fugitive dust sources would occur at the construction sites. The main line is anticipated to be completed by the early 1980s. The private line from the Rochelle Mine to the Panhandle Eastern Gasification Plant should also be completed in the early 1980s. Construction of these lines would not have a regional impact, because emissions would affect small areas and would be temporary.

Diesel locomotives operating on the railroad lines would increase emissions. These emissions would be intermittent and confined to a narrow corridor following the lines. Exact schedules of train operation do not exist, making predictions using dispersions impossible. It is expected that train operations would contribute less than 1% of the total particulate emission from the mines. Gaseous pollutant emissions would be less than one-eighth of those for all the towns and other coal-related activities. The locomotive emissions would be spread out over all railroad lines. Thus, railroad-associated emissions are expected to have little effect on regional air quality.

After construction, fugitive dust emissions from the transmission lines and the railroad rights-of-way would have a negligible impact on the regional TSP concentrations. Hence, these projects were not modeled for the air quality analysis.

Modeling Procedures

The annual average SO_2, NO_2, and TSP concentrations were predicted with a model based on the steady-state Gaussian dispersion equation presented in the *Workbook of Atmospheric Diffusion Estimates* (Turner 1972). Statistical meteorological data constructed from observations taken at the National Weather Service station in Moorcroft, Wyoming for 1950-1954 and Casper, Wyoming for 1970-1974 was input to the dispersion model. The modeling procedure for predicting annual pollutant concentrations from the mine and the urban areas is described in the technical report for Chapter 4 of the regional analysis, available at the Bureau of Land Management Casper District Office.

The 24-hour and 3-hour pollutant and SO_2 concentrations in the towns were estimated from predicted annual concentrations using Larsen statistics (Larsen 1971). All emissions of sulfur oxides were assumed to be sulfur dioxide (SO_2). All nitrogen oxides emitted to the atmosphere were assumed to be converted to nitrogen dioxide (NO_2).

TABLE R4-2
EMISSIONS OF PARTICULATES, SO_x, AND NO_x FROM OTHER COAL-RELATED ACTIVITIES AND URBAN AREAS (TONS/YEAR)

Source	Pollutant	Year 1980	1985	1990
Coal-Related Activities				
Wyodak Power Plant	Particulates	1,755	1,755	1,755
	SO_x	14,100	14,100	14,100
	NO_x	11,227	11,227	11,227
Dave Johnston Power Plant	Particulates	18,542	18,542	18,542
	SO_x	19,637	19,637	19,637
	NO_x	19,053	19,053	19,063
Panhandle Eastern Coal Gasification Plant	Particulates		1,376	1,376
	SO_x		11,884	11,884
	NO_x		13,667	13,667
Urban Areas				
Gillette	Particulates	248	380	482
	SO_x	263	402	511
	NO_x	1,434	2,179	2,778
Moorcroft	Particulates	51	80	99
	SO_x	44	69	84
	NO_x	252	402	489
Glenrock	Particulates	62	102	91
	SO_x	47	73	73
	NO_x	328	500	507
Douglas	Particulates	124	274	241
	SO_x	99	219	193
	NO_x	686	1,500	1,325
Casper	Particulates	2,146	2,493	2,905
	SO_x	2,358	2,745	3,190
	NO_x	6,913	8,041	9,709

TABLE R4-3

PROJECTED POPULATIONS INCREASES FOR CITIES IN AND NEAR THE REGION
(Above 1978 Base)

Urban Areas	Year 1980	1985	1990
Gillette	1,903	7,933	13,255
Moorcroft	286	1,161	1,679
Douglas	870	7,555	6,180
Glenrock	437	1,842	1,914
Casper	1,373	9,284	18,481

Note: Probable future development includes the site-specific action, existing coal-related activities, and municipal development.

Air Quality Impacts Resulting from Cumulative Regional Development

Predicted annual TSP concentrations are shown on Figures R4-1, R4-2, and R4-3. Significant TSP concentrations would occur in the area in southeast Campbell County encompassing the Caballo, Belle Ayr, Pronghorn, Cordero, and Coal Creek mines. The area is a strip 22 miles long and approximately 2½ miles wide. In this area annual TSP concentration would be 30 micrograms per cubic meter ($\mu g/m^3$), which is only 6 $\mu g/m^3$ above the rural background concentration. Concentrations would reach 35 $\mu g/m^3$ in the area between mines situated close to one another. The increase in TSP concentration would drop to 1 $\mu g/m^3$ 10 miles away from any of the mines. The annual and 24-hour Wyoming air quality standards of 60 $\mu g/m^3$ and 150 $\mu g/m^3$ may be exceeded at the boundary of some of the existing mines.

Emissions due to Gillette's population growth and interactions with the Rawhide and Eagle Butte mines (north of Gillette) are expected to produce annual TSP concentrations of 31 $\mu g/m^3$. This impact is confined to the area containing Gillette and the two mines. Concentrations nearer to Gillette are expected to reach 35 $\mu g/m^3$ in 1985 and 40 $\mu g/m^3$ in 1990. The highest 24-hour TSP concentrations are expected to occur in Gillette. A 24-hour concentration of 119 $\mu g/m^3$ is predicted in 1985 and 136 $\mu g/m^3$ in 1990. It is possible that Wyoming's 24-hour TSP standard (150 $\mu g/m^3$) may be violated in downtown Gillette, but it is unlikely that the national primary standard of 260 $\mu g/m^3$ would be reached.

Note that under the new national prevention of significant air quality deterioration (PSD) regulations (43 CFR 118), TSP violations would not occur. In fact, the emissions from surface mines would be well within the applicable standards.

TSP concentrations surrounding the town of Moorcroft would be small in 1980 and 1985. In 1990, Moorcroft TSP concentrations could reach 30 $\mu g/m^3$.

The annual and short-term SO_2 and NO_2 concentrations surrounding Gillette are expected to increase significantly during the study period. Annual SO_2 concentrations of 8 $\mu g/m^3$ in 1980 would increase to 23 $\mu g/m^3$ in 1990. A maximum 24-hour concentration of 78 $\mu g/m^3$ and 3-hour concentration of 129 $\mu g/m^3$ are predicted to occur in 1990. Although these are relatively large increases they are all below the Wyoming annual standard of 60 $\mu g/m^3$, the 24-hour standard of 260 $\mu g/m^3$, and the 3-hour standard of 1,300 $\mu g/m^3$. Annual NO_2 concentrations surrounding Gillette would increase from 40 $\mu g/m^3$ in 1980 to 50 $\mu g/m^3$ in 1990. These levels are well below the federal and state standards of 100 $\mu g/m^3$. The annual and short-term NO_2 and SO_2 concentrations surrounding Moorcroft would be small during the study period. Predicted annual gaseous pollutant concentrations are shown on Figures R4-4 through R4-9.

Away from the town and mines, the average annual horizontal visibility related to atmospheric particulates is expected to remain near the regional baseline of 54 miles. The annual visibilities related to atmospheric particulates in Gillette are estimated to decrease from 28 miles in 1980 to 22 miles in 1990.

The Chapter 4 Technical Report, on file at the Casper District Office of the Bureau of Land Mangement, contains additional TSP, SO_2, and NO_2 analyses of the probable level of development discussed in this chapter.

TOPOGRAPHY

Coal mining has altered the topography of 2,515 acres (.05% of the region) at ten mine sites to date (1978). Of this area, 1,234 acres (.02% of the region) have been reclaimed to a more gentle, smoother surface, generally 10 to 40 feet lower than originally existed. The remaining 1,281 disturbed acres (.03% of the region) are currently in pit and spoil pile topography.

By 1980, topography of 4,733 acres (.09% of the region) at fifteen mine sites would be altered. Of this area, 3,495 acres at the existing mine sites (.07% of the region) would be reclaimed, and 1,238 acres (.02% of the region) would remain in pit and spoil pile topography.

By 1985, topography of 12,934 acres (.26% of the region) at fifteen mine sites altered. Of this area, 9,887 acres (.20% of the region) would be reclaimed, and 3,047 acres (.06% of the region) would remain in pit and spoil pile topography.

By 1990, topography of 19,106 acres (.39% of the region) at fifteen mine sites would be altered. Of this area, 12,666 acres (.25% of the region) would be reclaimed, and 6,140 acres (.13% of the region) would remain in pit and spoil pile topography.

Topography has been changed slightly for coal mine support facilities (rail spurs, access roads, telephone lines, power lines, and mine structures), at sites of coal-related development (power plants, gasification plants, and main line railroad), and at areas of municipal development. The main impact to topography is at cut and fill sites to maintain grade along roads and railroads. By 1978, 72 miles of roads and railroads have been built. By 1980, it is anticipated there would be 195 miles of roads and railroads; by 1985, 235 miles; and by 1990, 235 miles. The above miles of road and railroad construction affect 1,449 acres in 1978; and would affect 3,987 acres by 1980, and 4,737 acres by 1985 and 1990.

Topography changes at uranium mine sites would be similar to those changes at the coal mines. In 1978, 3,000 acres (.06% of the region) have been disturbed by mining at three projects, and 1,000 acres (.02% of the region) only slightly disturbed by construction of two mills. Five hundred acres have been reclaimed.

By 1980, 4,700 acres (.09% of the region) would be disturbed by mining at six projects, and 1,500 acres (.03% of the region) would be only slightly disturbed by construction of three mills. One thousand mined acres (.02% of the region) would be reclaimed.

By 1985, 11,800 acres (.24% of the region) would be disturbed by mining at twelve projects, and 3,500 acres (.07% of the region) would be only slightly disturbed by construction of seven mills. Six thousand mined acres (.12% of the region) would be reclaimed.

By 1990, 18,300 acres (.37% of the region) would be disturbed by mining at twelve projects, and 3,500 acres

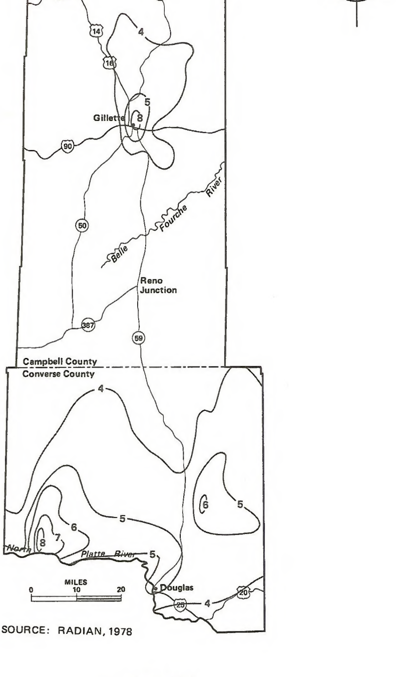


Figure R4-4
PREDICTED AMBIENT SO_2 CONCENTRATIONS ($\mu g/m^3$) FOR THE PROBABLE LEVEL OF DEVELOPMENT IN 1980

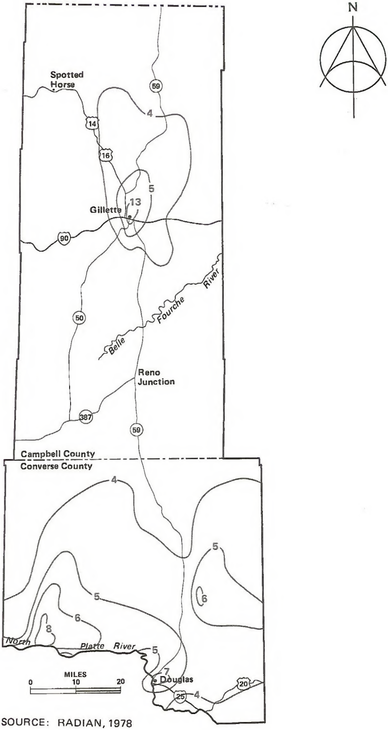


Figure R4-5
PREDICTED AMBIENT SO_2 CONCENTRATIONS ($\mu g/m^3$) FOR THE PROBABLE LEVEL OF DEVELOPMENT IN 1985

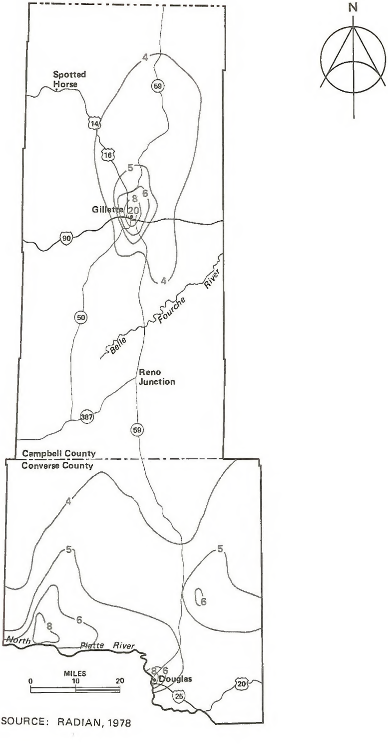


Figure R4-6
PREDICTED AMBIENT SO_2 CONCENTRATIONS ($\mu g/m^3$) FOR THE PROBABLE LEVEL OF DEVELOPMENT IN 1990

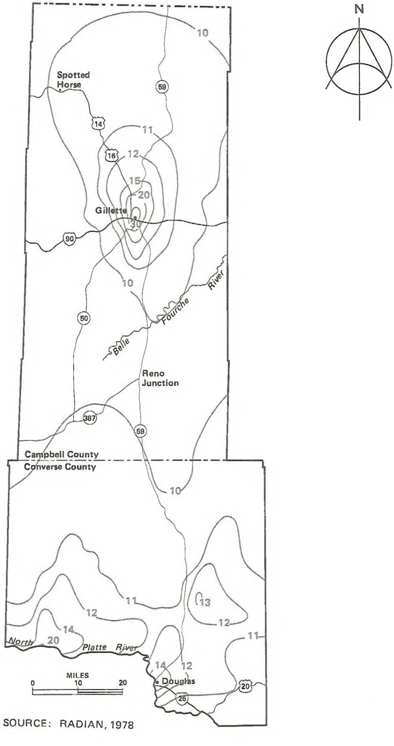


Figure R4-7
PREDICTED AMBIENT NO_2 CONCENTRATIONS ($\mu g/m^3$) FOR THE PROBABLE LEVEL OF DEVELOPMENT IN 1980

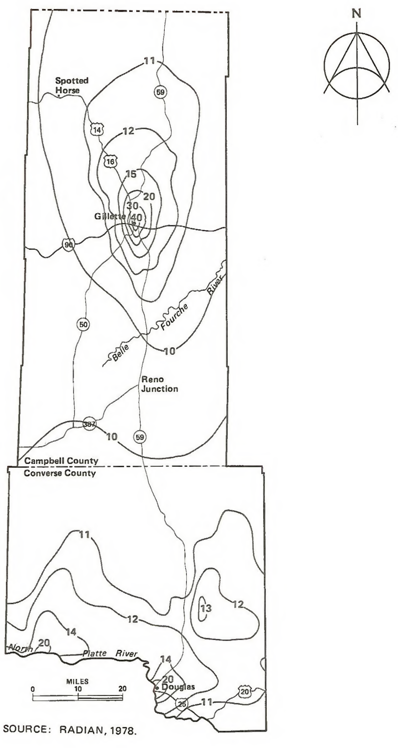
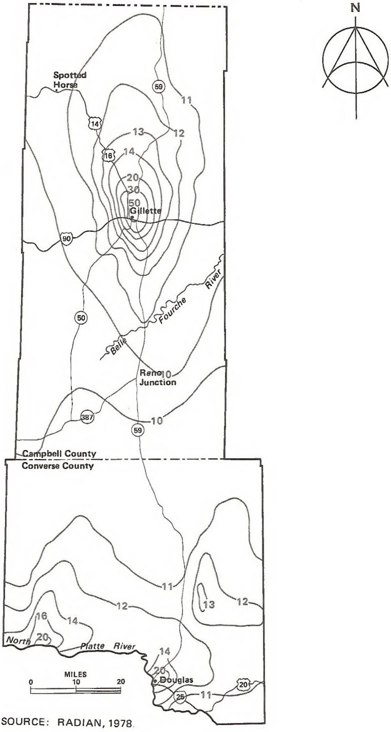


Figure R4-8
PREDICTED AMBIENT NO_2 CONCENTRATIONS ($\mu g/m^3$) FOR THE PROBABLE LEVEL OF DEVELOPMENT IN 1985



SOURCE: RADIAN, 1978

Figure R4-9
PREDICTED AMBIENT NO_2 CONCENTRATIONS ($\mu g/m^3$) FOR THE PROBABLE LEVEL OF DEVELOPMENT IN 1990

(.07% of the region) would be only slightly disturbed by construction of seven mills. Twelve thousand acres (.24% of the region) would be reclaimed.

Quarrying of sand, gravel, and scoria has disturbed 200 acres (.004% of the region) to date, and this figure is expected to be the same by 1980. By 1985, 620 acres (.01% of the region) would be disturbed by quarrying of these resources, and it is expected that 100 acres (.002% of the region) would be reclaimed. By 1990, 1,280 acres (.02% of the region) would be disturbed by quarrying, and 300 acres (.006% of the region) would be reclaimed.

Oil and gas development has caused only slight disturbance to the topography of the region; 4,800 acres (.09% of the region) have been disturbed by 1978, and of this, 400 acres (.008% of the region) have been reclaimed. By 1980, 4,880 acres (.09% of the region) would be disturbed, and 400 acres (.008% of the region) would be reclaimed; by 1985, 5,110 acres (.10% of the region) would be disturbed, and 450 acres (.009% of the region) would be reclaimed; and by 1990, 5,250 acres (.10% of the region) would be disturbed, and 500 acres (.01% of the region) would be reclaimed.

GEOLOGY

Strip mining would result in the loss of geologic record at the mine sites. Formations affected would be the Paleocene Fort Union Formation; the Eocene Wasatch Formation; and the Quaternary surficial deposits including soil, valley fill, terrace gravels, and scoria. This loss is not considered to be of great importance at present because the strata of both the Fort Union and Wasatch formations are of fairly uniform lithology throughout the Powder River Basin and there would still be a large area and volume of undisturbed geologic record of both formations outside the mine sites. A beneficial impact of mining would be exposure of geologic sections that would otherwise never have been available for scientific examination.

Geologic Hazards

Because replaced spoil settles over time, ground stability may be altered where surface mining has occurred. Ground stability has been altered to an average depth of about 150 feet over 1,234 acres to date. Stability would be altered over 3,495 acres by 1980, 9,887 acres by 1985, and 12,666 acres by 1990. This could affect both future construction on, and seismic exploration for deeper mineral resources such as oil and natural gas through the reclaimed fill.

Decreased ground stability may preclude construction of permanent structures on the reclaimed areas, depending on the way in which the overburden is reclaimed. According to the Geological Survey, Engineering Geology Branch, (personal communication, Richard C. Dunrud 1978), overburden that is piled in rows and leveled by bulldozer would probably be less stable than the original surface, but overburden that is returned to the pit and compacted could be as stable or possibly even more stable than the original surface. Dunrud and Osterwald (1978) state,

> The stable slope angle of fractured and jointed bedrock on strip mine highwalls ultimately may be less than the stable slope angle of a broken up pile of the same rock, because open joints and tension fractures behind the rims of highwalls provide avenues for water to flow, as well as to freeze and thaw, whereas the broken counterpart of the bedrock in spoil piles at the angle of repose appears to be less permeable and therefore less susceptible to the effects of water. Graded spoil material, however, might absorb surface water readily and fail unless the graded slopes are designed in accordance with soil engineering properties of the broken up and mixed overburden material (Terzaghi and Peck, 1967, p. 31-35; Lambe and Whitman, 1969, p. 33-38).

Ground stability at any one mine site is probably of little importance, because surface facilities connected with mining would already have been built on undisturbed ground, and spoil areas would be reclaimed primarily for grazing and wildlife habitat. Sites for future seismic exploration could be located outside the reclaimed areas. However, as mining progresses in the region, an area of altered stability to an average depth of about 150 (60 to more than 400) feet could develop along the area of coal outcrop, a strip about 1 to 12 (generally less than 6) miles wide and more than 100 miles long. As a result of coal removal, this area would become a trough an average of about 50 feet lower than the present configuration of the land.

Paleontology

Impacts to paleontological resources would consist of losses of plant, invertebrate, and vertebrate fossil materials for scientific research, public education (interpretative programs), and other values. Losses would result from destruction, disturbance, or removal of fossil materials as a result of coal mining activities, unauthorized collection, and vandalism. Fossil materials of Quaternary through Pennsylvanian age occurring in a number of formations (see Table R2-6) would be impacted to variable degrees.

A beneficial impact of development would be the exposure of fossil materials for scientific examination and collection which might never occur except as a result of overburden clearance, exposure of rock strata, and mineral excavation.

All exposed fossiliferous formations within the region could also be affected by increased unauthorized fossil collecting and vandalism as a result of increased regional population. The extent of this impact cannot be presently assessed due to a general lack of specific data on such activities.

SOILS

Mining and other activities would impact soils by alteration of existing soil characteristics and properties. These include soil microorganism composition, structure, texture, organic matter content, infiltration rate, permeability, water-holding capacity, nutrient level, soil-climatic relationship, and productivity, all of which have developed over geologic time (U.S. Department of Interior 1975, 1976a). The established levels of soil productivity would be lost and probably not fully recover to present levels in the long-term (based on analysis of one site as discussed in Chapter 3 of the site-specific analysis). The quality and quantity of "topsoiling"material and change in soil productivity after reclamation is quantifiable through the land capability and range site systems for individual sites (see Chapter 3 of the site-specific analysis), but not on a regional basis.

The exposure, compaction, burial, stockpiling, disturbance, and contamination of surface soil would cause reductions in the current levels of soil productivity and increase soil loss from wind and water erosion. Stockpiling surface soil material would degrade biological, chemical, and physical properties, causing reductions in productivity when used in reclamation (ibid., Monsen 1975). Accidental spills of oil, gasoline, and other toxic materials could contaminate and sterilize the soil horizons, rendering the affected soil unusable for reclamation, but such accidents would be localized and of little relative significance. Any such contaminated material would be buried as required by the Surface Mining Control and Reclamation Act (SMCRA).

Mining could expose material which contains chemical constituents (such as selenium, boron, or uranium) that would be harmful to plants and animals. These materials could exist in the overburden material of the Fort Union Formation (see Chapter 2, Water Resources). Any such material identified would be buried as required by SMCRA. Other materials found in the area that could hamper reclamation include those of high alkalinity or salinity, sand or clay-textured material, and material with low cation-exchange capacities (see Appendix B, Soils).

All of the regional development activities would result in accelerated erosion by wind and water due to exposure and increased activity, until the soil is revegetated (Monsen 1975). Wind action, which is fairly constant over the area, would cause fine particles to be lifted from the exposed surfaces and blown away (see Chapter 4, Air Quality). Prior to revegetation of exposed, disturbed, and stockpiled soils, high intensity storms (possibly occurring about 1 year in 10 years to 1 year in 25 years), occurring mainly in late May or June, could lead to increased water erosion (Becker and Alyea 1964). The increased erosion would result from the disturbed soils not having any protective cover and inability of the soil to soak up the water. Such losses are not possible to quantify. A range of soil loss due to erosion can be estimated on a site-specific basis (see Chapter 3, Soils, of the site-specific anaylsis).

Future population increases in the region would impact the soil resource. Permanent loss of soil surface would result from the construction of housing and support facilities. Also, the increase in population would result in greater use of the region's soils for recreation, particularly by off-road vehicle users. Greater off-road vehicle use would result in increased soil compaction in the localized area of use and an accelerated rate of soil erosion. The loss in the soil resource as a result of increased off-road vehicle use is nonquantifiable.

For a summary of cumulative acreage disturbed and reclaimed by coal mining activity under the probable level of development, refer to Table R1-5 in Chapter 1.

For a summary of cumulative acreage disturbed and reclaimed by all regional development activities under the probable level of development, refer to Table R1-6 in Chapter 1.

WATER RESOURCES

Groundwater

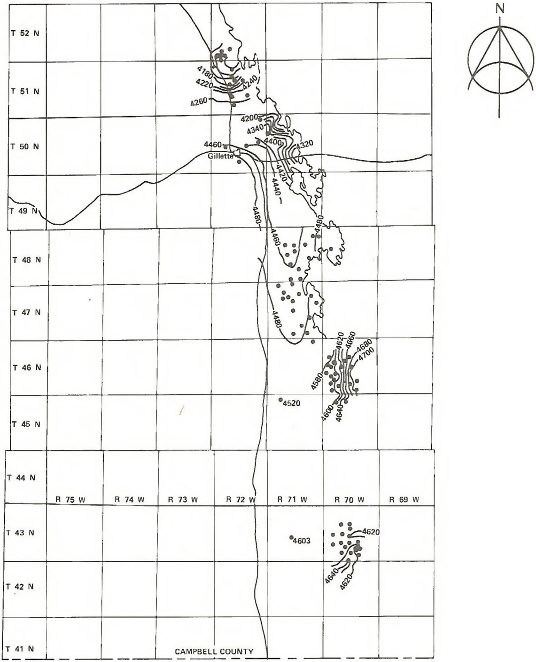
The water levels in lateral equivalents of the aquifers destroyed by coal mining would be lowered. Figure R4-10 shows the potentiometric surface in the Wyodak coal as it probably existed when only the Wyodak Mine was in operation. The depression in the vicinity of the mine is graded to the base of the mine pit which is at an elevation of about 4,300 feet, about 100 feet lower than the surrounding terrain. There are now nine mines in operation, or under construction, and six more may be in operation by 1990. A depression, such as that at the Wyodak Mine, would develop in the potentiometric surface in the coal at each mine except Dave Johnston, where the coal reportedly is above the zone of saturation.

In the southern part of Campbell County this would result in local reversal in flow; recharge areas would become discharge areas. In the central part of the county where there is a trough in the potentiometric surface which trends northward, flow would be permanently disrupted. The area near Gillette would remain a discharge area, but the discharge would be focused at the mines.

The extent of the lowering of water levels in the overburden would depend on the areal extent and thickness of the aquifers. Because of the presence of shale, the base level to which the overburden aquifers will drain would be the base of the aquifer, and not necessarily the bottom of the mine. Where these aquifers are truly water table, drawdown would not exceed the thickness of the individual aquifer and the drawdown would approach the aquifer thickness only at the mine face.

The lowering of water levels in the coal and overburden aquifers would affect water levels in some nearby wells and decrease natural discharge which is by seeps and springs, by evapotranspiration, and to streams. Discharge from the bedrock, overburden, and coal may also be into the alluvium where it is evapotranspired, discharged into streams, or moves out of the area as underflow in the alluvium.

Much of the water flowing into a mine is used in the operation of the mine. Excess water, which accumulates at times, is discharged into the present streams. Because



• WELL COMPLETED IN THE WYODAK COAL SEAM

—4620— ELEVATION OF GROUNDWATER SURFACE IN THE WYODAK COAL SEAM

EASTERN EDGE OF THE WYODAK COAL SEAM (CENTRAL REGION) ADAPTED FROM DENSON AND KEEFER, 1974

Figure R4-10

WATER LEVELS IN THE WYODAK COAL SEAM IN CENTRAL AND SOUTHERN CAMPBELL COUNTY, WYOMING

the streams are often dry and because of the variability of the chemical quality of both the surface water and the groundwater, it is not possible to compare the quality of water that may be discharged into a stream with the quality of water in the stream. However, in many instances water seeping into a mine is of the same quality as that developed elsewhere in the region for stock and domestic purposes. A discharge permit governing the quantity and quality of water is required before any water can be discharged into a stream.

Stripping of alluvium that has been determined to be an "alluvial valley floor"under the definition of the Surface Mining Control and Reclamation Act of 1977 would have to comply with the standards of the act. One provision of the act is that disturbance to the prevailing hydrologic balance at each mine site and associated offsite areas will be minimized by, among other measures, "preserving throughout the mining and reclamation process the essential hydrologic functions of alluvial valley floors in the arid and semiarid areas of the country"

The impact of lowering water levels in the overburden and coal aquifers would be minor. Stock and domestic wells basinward a few miles perpendicular to the outcrop generally tap bedrock aquifers in stratigraphic horizons higher than the overburden. Although lowering of water levels in the aquifers closer to the mines is anticipated to be small, where wells are adversely impacted, the impacts can be mitigated by deepening the wells.

Water levels would be lowered in aquifers below the coal because of development for plant requirements and additional development for municipal supplies.

The acreage reclaimed during successive periods is shown in Table R1-6. The extent to which the reclaimed spoil would be saturated is not known; however, a study by Rahn (1976) indicates that the spoil is potentially able to transmit water nearly as well as the aquifers it replaces. Water in the spoil would be under water-table conditions; further, the plans submitted for postmining topography of some mines show the land surface, at least in part, lower than the original potentiometric surface. Therefore, the original groundwater movement would not be restored by reclamation.

In recharge areas, the quality of water in the spoil would be similar to that described for the alluvium in Chapter 2 and would be poorer than the quality that occurred in some of the destroyed aquifers. However, because the chemical environment would not be changed in the adjoining aquifers, water moving from the spoil into adjoining aquifers would undergo reactions described in Chapter 2 such that dissolved common ions and trace elements in the water a short distance from the mine would be the same as before mining.

In areas where bedrock aquifers discharge into spoil, the water moving into the spoil would probably increase somewhat in dissolved constituents.

One coal gasification plant is projected to be in operation by 1990. The plant would require about 7,000 acre-feet of water annually, and the water sources being considered include the Madison Limestone, the Lance Formation, and the Fox Hills Sandstone. Until the quantity and source of groundwater that would be used is known, no estimate of impacts on supply can be made. Further, other environmental impacts cannot be assessed without a description of what by-products, if any, would be allowed to enter into the hydrological system.

The impacts of uranium mining, particularly with regard to potential hazard to quality of groundwater, require additional study. However, in the southern part of the region, which is the principal uranium area, the sandstone aquifers are apparently better aquifers than those to the north. Ranchers have reported mining and milling operations have adversely impacted some stream reaches with perennial flow and have caused at least one well to cease flowing.

Changes already occurring in the regional groundwater system are discussed further in Chapter 8, Low-Level Scenario.

Surface Water

Large areas mined within the region as of 1978 are depleted of point-watering sources for stock and wildlife amounting to about 8 square miles (5,028 acres) for coal-related activity and about 27 square miles (17,574 acres) for coal plus other development activity. These areas would be increased as indicated in Tables R1-5 and R1-6 of Chapter 1. These tables also show estimated reclaimed areas. Of the presently disturbed areas, approximately 75% of coal-related disturbed areas (3,794 acres) and approximately 90% of coal-related plus other disturbed areas (15,940 acres) are unreclaimed. This leaves large areas susceptible to erosion and to contamination of surface water from the mine spoil leachate and mine effluent during the life of the mines and their reclamation.

Mining would eliminate the present subsurface ground structure under the drainages of streams which flow parts of most years. These streams provide many point-watering sources, shade trees, and forage for stock and wildlife during part or all of most years. Although this flow is insignificant in its total volume, and normally succumbs to evapotranspiration not far from its appearance in the stream, it is very important if the area is to be reclaimed to its former use of stock ranching. Table R4-4 is an attempt to estimate the possible loss of wet stream, pond, and shallow well, point-water sources.

Impacts due to the interception by mining operations of drainages (estimated from about 650 square miles now to about 1,100 square miles by 1990) are difficult to evaluate; most of this drainage would be bypassed in temporary channels around or through the mines. Since the designs of these channels must normally provide for a large flood (from a storm return period greater than 100 years) before they are approved by the State Engineer (personal communication, Paul Thompson 1977), there should be little chance of an adverse impact from floods. If a major flood beyond the design capacity of the bypass channels or detention structures should occur, an increased sediment and chemical contaminant load might occur if not intercepted by the mine pit. Data are insufficient to quantify any such occurrence.

TABLE R4-4

IMPACTS TO SURFACE WATER AT PROBABLE LEVEL OF PRODUCTION

Impacts	1978 All Activity**	1980 All Activity**	1985 All Activity**	1990 All Activity**	Long Term* All Activity**
Estimated depressions in square miles (40, ± 10% will probably be fed by groundwater).	0.2 to 0.3	0.6 to 0.9	1.8 to 2.6	2.5 to 3.6	9½ to 13***
Estimated potential intercepted drainage area in square miles.	(None till end of final reclamation)				620 to 2,000
Estimated lost point-water sources:					
Ponds in acres (includes flowing wells, springs, playas, and lakes).	110	150	260	330	440
Wet streams in miles (perennial sections and wet-pothole sections).	16	23	39	49	80
Estimated potential sedimentation in acre-feet per year.	160	200	290	340	--
Total water use, cubic feet per second (see Table R1-8).	68	74	94	97	--
Water use by coal only, cubic feet per second.	1.4	3.0	4.7	4.8	--

Note: The greatest impact in the region may occur to the quality of the water. There is not enough data available to quantify this degradation; see text for qualitative analysis.

* After mining and reclamation is done.

** Includes all mines and plants and related development.

*** Estimated water loss due to evaporation = 6,400 acre-feet/year or 9 cubic feet/second.

Mine effluent would most likely average less than a half of a cubic foot per second (cfs) per mine, much of which would be used for dust suppression. The water used for dust control would evaporate, leaving a residue of salts, trace metals, and other contaminants on the surface of roads and in ditches. It may later escape from the mine area as drainage patterns change during mining. Water pumped into evaporation or storage ponds would concentrate contaminants with time, causing the ponds to become sinks of very high concentration. Overtopping of these ponds by flooding could cause contaminant drainage out of the mine area. Data are not available to quantify this contaminant accumulation.

Most investigators of the chemical quality of water in spoil of rehabilitated coal mine areas agree that this water (source of surface water) is more highly mineralized than the groundwater in undisturbed formations. They are also in agreement that the greatest pollution impact might be due to a possible increase in the concentration of heavy metals. Some are toxic to plants and animals even at low concentrations.

Table R4-5 shows: that the coal and overburden leachates are greater in heavy metal concentration than the natural surface waters in almost all cases; that the concentration of heavy metals in the soil is a potentially large source of supply; and that dissolved concentrations already in the surface water almost exceed public water supply standards. Heavy metal concentration from the mine leachate exceeds recommended maximum concentration for irrigation on a continuous basis, livestock use, public water supply, and aquatic biota. For this reason, reclamation efforts must attempt to trap all leachate and intercepted surface flows from small drainages within the mine areas. Flows which escape the mining areas carrying the heavy metal contaminants would expose forage and crops to these contaminants. Repeated irrigation by such water could increase concentration in plants to the point that growth could become stunted. The greatest hazard, however, might be the place in the food chain of such plants. Stock and humans eating the contaminated plants and crops would in turn be accumulating these heavy metals. Human consumption of the contaminated animals would also add to the accumulation of heavy metal concentration in humans, possibly above the levels which might be tolerated. Data are not available to estimate the extent of this possible danger. (Total dissolved mineral content of water from replaced overburden material at the Amax Belle Ayr Mine was found not greatly different from water in undisturbed overburden or coal, Davis and Rechard 1977; however, the overburden water could be higher in trace metals (confirmation through more study is needed), personal communication, Paul Rechard 1978.)

Leachate from mines from which coal is used in the gasification process should be more toxic than that from other coal mines. This is due to the fact that the ash from the processing and gasification plant would be dumped in with the mine spoil (and covered with a minimum of 6 feet of spoil). Brine and other mill waste would be mixed into the ash at the mill, concentrating many of the contaminants which were in the coal and in the processing chemicals and gases. Soluble salts amount to about 4% of the weight of the ash (SERNCO 1974).

Coal gasification plants along with electric power plants (water cooled) are the greatest industrial water consumers, each requiring about 14 cfs. (For comparison, total streamflow originating off each square mile of the region is about 260 cfs, and the total streamflow exiting over the borders of the region equals about 110 cfs.)

Only slight adverse impact due to increased erosion is anticipated with the reclamation called for in state and federal standards (see Chapter 3): reclaiming to the natural average or flatter slopes; restoring to the approximate original contour; revegetating the replaced spoil material; preserving the natural surface drainage; and returning alluvial floors to their original hydrologic function. (This includes returning floodplains and the original sinuosity of the stream beds close to the undisturbed, natural condition).

If, however, reclamation proceeds as indicated by many of the submitted mine plans, progressive differential settlement would most likely occur. This could cause reclaimed drainage patterns to shift from that planned for reclamation and could cause potholes to form. (Consolidation and shifting occurs in reclaimed spoil, Davis and Rechard 1977.) The changed tributary drainage patterns would cut new stream paths and cause gullying. (The larger channels would be replaced at the same elevation and slope as before mining whereas the tributary channels would not.) Tributary channels from unmined land to the larger channels would have steeper slopes due to lowering of part of the drainage (lowered by the amount of coal removed minus the amount of overburden swell). These changing tributary channels would probably cause headcutting, sedimentation, and loss of reclaimed land until the channels hydraulically adjust to their new ground slopes. However, potholes and depressions forming (see Table R4-4) would trap silt and surface runoff, causing decreased sedimentation and increased infiltration to the groundwater supply. Data are not available to quantify sedimentation due to these impacts.

Sedimentation impact could be greatest from the unreclaimed overburden. During the high intensity thunderstorms common to the region, large amounts of sediment from the spoil piles may find their way into the bypass channels around the mining operations, thence out of the mining area, thus providing an unnatural sediment source to be carried downstream during subsequent stream flows. Shown, Hadley, and Ringen (report in preparation) found the sediment yield from a basin containing a nonrehabilitated mine to be about eight times that from a neighboring basin. Combined with the two sediment studies mentioned in Chapter 2 which indicate an average erosion rate of about 0.8 to 0.9 acre-feet per square mile per year, a sedimentation estimate of about 7 acre-feet per square mile per year is derived for unreclaimed mining areas.

Rehabilitated or reclaimed mine spoils were studied by Lusby and Toy (1976) on two mines, the Dave Johnston Mine near the southern end of the region, and the Big Horn Mine near Sheridan. They found that streamflow runoff and sediment were generally higher on the re-

TABLE R4-5

COMPARISON OF MAXIMUM HEAVY METAL CONCENTRATIONS IN SURFACE WATERS IN THE LITTLE POWDER, CHEYENNE, AND BELLE FOURCHE RIVERS; BLACK THUNDER MINE LEACHATES; SOILS AND SACEBRUSH SAMPLES THROUCHOUT THE RECION; AND RECOMMENDED MAXIMUM CONCENTRATIONS FOR PROTECTION OF VARIOUS WATER USES

	Maximum Observed Concentration (ppb)[a]					Recommended Maximum Concentration for Protection of Water Uses (ppb)[a,c]				
	Surface Water[k]		Coal & Overburden Leachates[b]							
Heavy Metal	Total	Dissolved	Black Thunder Mine	Soil[c]	Sagebrush[c]	Irrigation[d] (continuous use)	Irrigation[d] (20-year use)	Livestock	Public Water Supplies	Aquatic Biota
Arsenic	55	3	90	---	---	100	2,000	200	100	1,000
Beryllium	10	10	120	1,500	---	100	500	e	f	f
Cadmium	20	3	400	30,000	---	10	50	50	10	3[g]
Copper	140	5	320	50,000	---	200	5,000	500	1,000	15[h]
Lead	200	4	10	100,000	150,000	5,000	10,000	100	10	30
Mercury	0.8	0.2	1	40	---	f	f	10	2	0.05[i]
Molybdenum	14	16	23	20,000	30,000	10	50[j]	f	f	f
Selenium	7	7	21	---	4,800	20	20[j]	50	10	f

a Parts per billion or micrograms per liter.
b Source: University of Wyoming, Black Thunder Project Research Team 1976.
c Source: Conner, Keith, and Anderson 1976.
d Based on irrigation rate of 3 acre-feet/acre/year.
e Because of inadequate date, no maximum water quality criterion was recommended for beryllium; however, a daily dosage of 18 mg/kg body weight apparently had no adverse effects on laboratory rats.
f No recommendation given.
g Recommend 3 ppb in hard water and 0.4 ppb in soft water.
h No recommendation given, but 15-33 ppb appear to be safe for reproduction by fathead minnows in hard water.
i No recommendation for total inorganic mercury but recommend no more than 0.05 ppb average total mercury (inorganic plus organic) and 0.2 ppb total mercury at any time or place.
j Based on toxicity of forage to livestock rather than phytotoxicity.
k Source: Reports of the Ceological Survey.

claimed land than on the undisturbed land. They said that this might be attributed, however, to increased slopes, increased clay content of the surface soil, and decreased root density of the vegetal cover.

Increased water use from 1978 has been projected at about 8% to 1980, 43% to 1985, and 50% to 1990. (Coal-related water use averages only about 4% or 5% of total water use whereas oil, uranium, and coal-gasification industries account for about 50% of total water use. See tables in Chapter 1.) No material increase in irrigation, stock water, rural domestic, or oil field water use is foreseen. Water supply for coal mining has been estimated at about 1,000 acre-feet per year now, and is projected to increase by about 220% by 1980, 340% by 1985, and 350% by 1990. Increase in water use due to municipal, mining, gasification plant, and power plant needs would most likely be met locally. Considering that the surface water supply has decreased once (about 1930) since records began and may do so again, and that it is economical to store only a portion of the total runoff in reservoirs for water supply, it appears that some of the future supply must either be imported or come from the ground. (The Wyoming State Engineer (1974) indicates that there may be groundwater available for municipal and limited industrial development in northeast Wyoming; however, data are not available to confirm this.) Large-scale groundwater withdrawals could result in hydrologic depletion of flow of streams and springs, and competition for the use of water with its present users, according to the Task Committee on Groundwater Hydrology, American Society of Civil Engineers (1977). Data are insufficient to quantify the above noted depletion of surface water.

Increased sewage due to increased population is estimated on Table R1-8. Efforts would be directed toward increasing capacities of present sewage disposal plants and including adequate systems in the design of new communities such as Wright. Increased salinity and harmful bacterial contamination would probably be noted in the North Platte River (the only perennial stream bordering or within the region). The increase, however, is not expected to be enough to endanger aquatic biota or downstream water users. Dissolved oxygen concentrations should not be lowered to dangerous levels. Sewage effluent discharged to ephemeral streams most likely would sink into the stream beds. Coliform contamination should be neutralized within a short distance downstream from the discharge points, except during periods of storm runoff; and salts accumulating in the stream beds would be flushed downstream during subsequent flows.

The greatest impact, and the longest lasting impact, to the water resource may be caused by the uranium rather than the coal-mining industry. Uranium mines plan to leave impoundments, large areas of unreclaimed acreages and deep lakes in some of the unreclaimed pits. Breakouts of abandoned impoundments and erosion from unreclaimed areas could degrade downstream flows. If the groundwater table intercepts the ground surface (as it would in the unreclaimed pits) downstream or down gradient from the spoil replaced in the pits, plants and animals could be exposed to water of poor quality containing toxic amounts of heavy metals. (Such heavy metals accumulate within the plant or animal, and dangerous levels may be reached.)

Potentially more dangerous however, especially on a long-term basis, is the possible radiological contamination from the uranium mills. Leachate in the tailings ponds is well beyond the safe limit for animals. Escape by infiltration to the water table or by breakout to stream drainages could cause contamination by dangerous levels of radioactivity. Stock or humans using water from wells down gradient from tailing ponds would be exposed. Plants and animals encountering contaminated flows or contaminated sediments deposited in drainage channels would be exposed. Increasing the danger is the nondegradable and accumulative character of this type of contamination. Plants, edible crops, and river biota accumulate and concentrate radium-226. Levels in wells near uranium mills in the Gas Hills area of Wyoming vary from less than 10 picocuries to 50 picocuries per liter. Concentrations as high as about 35 picocuries per liter have been noted in the Little Medicine Bow River in the Shirley Basin area of Wyoming. The United States Public Health Service limit for radium-226 is 3 picocuries per liter. (Sources for above are Clark and Kerr 1974, Tennessee Valley Authority 1976, and Nuclear Regulatory Commission 1977.)

VEGETATION

Under the probable level of development, all activity (coal mining, uranium mining, oil and gas activity, sand, gravel, and scoria extraction, access roads, railroads, power lines, power plants, a gasification plant, and population increases) would cumulatively disturb vegetation on 24,593 acres by 1980, 48,571 acres by 1985, and 62,645 acres by 1990. The disturbance on 25,966 acres would be reclaimed by 1990. (See Table R1-6.)

Coal mining activity alone under the probable level of development would disturb 8,421 acres by 1980, 16,622 acres by 1985, and 22,794 acres by 1990.

Table R4-6 lists the vegetation types disturbed in the region at the probable level of development.

Terrestrial Vegetation

For all development activity, the impact on vegetation would begin prior to actual extraction operations with the construction of access roads, surface facilities, rail spurs, power lines, and the associated population increase.

The destruction of terrestrial vegetative cover would result in impacts on livestock, wildlife, recreation, aesthetics, soil, and water. Within the reclamation process, the establishment of vegetative cover has to be accomplished before satisfactory control of soil erosion, improvement of water quality, or any use of the area by man or animal is feasible.

TABLE R4-6

VEGETATION TYPE DISTURBANCE IN THE REGION (IN ACRES AT THREE BENCHMARK DATES)

Probable Level of Regional Development	Sagebrush/ Grass	Scoria Grassland	Silver Sagebrush	Greasewood	Ponderosa Pine	Riparian	Others Combined	Total Acres
1980 Total	21,904	634	625	192	87	454	178	24,074
1985 Total	42,320	1,061	1,018	321	146	786	279	45,931
1990 Total	54,733	1,406	1,336	425	194	1,030	279	59,403

Note: Table does not include acreage disturbed due to population increase since it is unknown what types will be disturbed. This would amount to 519 acres by 1980, 2,640 acres by 1985, and 3,242 acres by 1990.

ENVIRONMENTAL IMPACTS OF REGIONAL DEVELOPMENT

Reclamation Success

Strip mining causes a greater impact to vegetation than to most other resources, both aesthetically and biologically. The success of vegetative rehabilitation depends upon a number of climatic and biotic factors, as well as the type of disturbance. Precipitation in the region varies from 12 inches in the southern part to 17 inches in northern Campbell County. Reclamation success is therefore expected to be more likely in the northern part of the region. In some years, climatic conditions such as droughts and sudden downpours could undo revegetation attempts. Revegetation is also dependent upon artificial restoration measures, since severely disturbed areas recover very slowly through natural regeneration. Factors which could hinder revegetation are less than ideal soil properties, steep slopes, loss of seeds, and destruction of seedlings by small mammals.

Despite such problems, successful reclamation appears to have been achieved in the region. Since the previous environmental statement on the Eastern Powder River Basin (FES 74-55), some observable results have been made available on reclamation success in the region and adjacent areas. The results enumerated below for two currently operating surface mines in the Eastern Powder River Basin were taken from *Rehabilitation Potentials and Limitations of Surface Mined Land in the Northern Great Plains* (Packer 1974).

Wyodak Resources Development Corporation (Wyodak Mine). This mine is on the Wyodak seam near Gillette. The top 10 feet of overburden is sandy and has no adverse chemical characteristics. Spoil banks have been graded to a level or gently sloping configuration. In the spring of 1972, the spoil banks were lightly disked and seeded to crested wheatgrass, green needlegrass, western wheatgrass, and fourwing saltbush. No supplemental irrigation was applied. Excellent stands were obtained by planting on spoils from both shallow and deep depths; however, vigor of stands grown on spoils derived from shallow depths was better. Short-term conclusions about this mine are that (1) the overburden from deep depths is not toxic, (2) spoil banks finished off with near-surface material provide better growth, (3) rehabilitation can be accomplished without irrigation, and (4) good rehabilitation success can be achieved.

Amax Coal Company (Belle Ayr Mine). This mine is on the Wyodak seam south of Gillette. The overburden, which consists of mixed sandstone, claystone, and shale, is quite sandy. No toxic or sterile overburden has been encountered. As at the Wyodak mine, the upper 10 feet of overburden is best for final emplacement on graded spoils. Spoils have been shaped to gentle slopes similar to the natural topography. No serious erosion problems exist. Amax, the University of Wyoming, and the Forest Service have established successful rehabilitation plantings at this mine. Amax has planted most of the areas that have been rehabilitated. Approximately 400 acres, used for spoil disposal from the mine pit, have been planted to grasses, forbs, and shrubs and are used for cattle grazing. Another 25 acres, more or less, have been planted to protect and stabilize mine spoils. The University of Wyoming has successfully established a number of grass and legume species on an experimental area of only a few acres. Similarly, the Forest Service has an experimental planting of several shrub and tree species (225 of each species), some of which have established successfully.

Among the grass and shrub species that have been successfully grown on the Belle Ayr Mine are western wheatgrass, green needlegrass, tall wheatgrass, and fourwing saltbush. No mulches or irrigation have been used in connection with these plantings. Some areas have been fertilized, however.

Short-term conclusions based on results of rehabilitation efforts are that (1) grading of spoils to gentle slopes reduces or eliminates erosion of the soil surface, (2) fertilizer improves initial growth while the ground is still moist, but apparently does not enhance survival after the ground dries, (3) native and adapted introduced grasses and shrubs establish and survive well, especially where the top 10 feet of overburden has been used to finish off the spoil surface, and (4) in years of average and above-average precipitation, initial establishment of adaptable plant species should not be difficult.

Since the above report was published in 1974, follow-up field checks were made in 1978. The Soil Conservation Service in Gillette reports (personal communication) that productivity on seeded spoil banks at the Belle Ayr Mine varies from 90% to better than 100% of the productivity on comparable nonmined areas. This productivity rate applies to areas seeded since 1972. (However, 1978 was an exceptionally good moisture year, with grasses growing over 2 feet tall.) The same revegetation success was exhibited at the Cordero Mine (5 miles south of the Belle Ayr Mine) in 1978.

More data on reclamation results will become available as the results of current studies are published.

Other Impacts

Selenium-converter plants convert selenium from a harmless state to a soluble form that can be absorbed by most grasses and forbs, thus rendering them poisonous to man and animals. It is reported that several genera and species of selenium-converter plants are growing on the Highland Uranium Mine reclaimed land (personal communication, J.D. Love, Geological Survey 1978). These converter plants were introduced into the Powder River Basin 50 to 75 years ago and have become established along the strike of seleniferous strata in the Wasatch and Fort Union formations. Their presence in the region makes it unsafe to leave seleniferous material as the topsoil layer in reclaimed areas.

The Wyoming Department of Environmental Quality (DEQ) is responsible for monitoring the results of reclamation. One of the things this agency could do is require eradication of the selenium-converter plants on the reclaimed land at the Highland Mine. DEQ and the Office of Surface Mining should be alerted to the possibility of the same problem occurring on coal mine sites.

The Surface Mining Control and Reclamation Act and Wyoming Land Quality Regulations require that soil and

overburden disturbed by coal mining must be tested, and that containing toxic material must be buried beneath harmless topsoil or spoil material.

The removal of vegetation from stripping areas, access roads, the main rail line, rail spurs, and its destruction under piles of overburden, would lead to increased use of remaining vegetation by livestock and wildlife. The railroads and access roads could act as barriers to livestock and wildlife movement and cause trailing or increased use on the vegetated area adjoining these facilities. The magnitude of these secondary impacts would depend on the importance of the area for wildlife and livestock forage.

Increased dispersed recreational use, particularly that involving off-road vehicle travel, would cause the disturbance of an indeterminate amount of vegetative cover. Baseline data are not available on acres of vegetation disturbed by this activity. An indication can be drawn from the magnitude of the anticipated population increase (refer to Chapter 4, Recreation and Socioeconomic Conditions).

Another population-related impact to vegetation would be wildfires. In 1976, 3,500 acres of vegetation were destroyed in the region by 82 wildfires. (These are figures actually submitted to State of Wyoming (personal communication, Mike Gagin 1977); unreported fires probably occurred.) The usual causes are lightning or human activities. The incidence of lightning-caused fires (22 in 1976) is expected to remain relatively constant as little or no change is anticipated in the climatic condition or fire potential in the vegetative communities of the region. The number of man-caused fires (60 in 1976) is expected to increase with expansion of the population. However this increase can be offset with quicker detection and response as a result of more people. Also more fire equipment would be available at mine sites.

Haul road dust and coal dust resulting from mining operations may be deposited on vegetation adjacent to the mine areas. Dust releases from one existing mine were estimated to amount to 44 pounds of dust per hour per mine (University of Wyoming, Black Thunder Project Research Team 1976). Dust-covered vegetation would be less palatable to livestock and wildlife and could become unfit for consumption until cleaned by rain, snow, or wind.

Another impact from the destruction of vegetative cover could be the invasion of noxious weeds or less palatable species of vegetation onto the disturbed areas. These weedy species would compete with and inhibit the reestablishment of desired permanent vegetative cover.

Young, palatable plants produced by revegetation efforts would attract livestock and wildlife. The grazing of the young plants, unless controlled, would inhibit growth vigor and could cause a delay in the establishment of vegetative cover.

Aquatic Vegetation

Mining would eliminate aquatic habitats in certain localized areas, for example Rawhide Creek on the Buckskin site (see Map 1, Appendix A, and Table R4-4). In nearby offsite areas, aquatic habitats in groundwater-fed ponds would probably be eliminated due to lowered water table levels.

Surface runoff from disturbed areas could increase the sediment load in streams. This increase would degrade the aquatic community and destroy individual plants by suffocation and abrasion.

Endangered and/or Threatened

As discussed in Chapter 2, no plant species listed as endangered or threatened are known to occur in the region. Hence, no adverse impact would be anticipated. However, all proposed mining and related areas would be examined to determine whether endangered or threatened plants exist.

FISH AND WILDLIFE

The effects of cumulative regional development on wildlife can be categorized by: (1) the loss of fish and wildlife habitat, (2) the resulting loss of fish and wildlife carrying capacity due to the loss of habitat, and (3) the loss of fish and wildlife populations and their progeny. The impacts to fish and wildlife habitat and populations are summarized in Tables R4-7 through R4-13.

Habitat Loss

Aquatic

Portions of Little Thunder Creek, Caballo Creek, and Rawhide Creek would be destroyed and diverted until final reclamation. Caballo Reservoir and Reno Reservoir No. 1 would be drained and mined. Numerous other small stock ponds would be destroyed by the mining process. The aquatic vegetation present in these areas supports populations of nesting ducks, grebes, red-winged blackbirds, shorebirds, muskrats, tiger salamanders, various frogs and turtles, and other nongame wildlife. Game and nongame fish would be detrimentally affected by the destruction of their habitat in these areas.

Surface water quality may be degraded by increased siltation, leaching of stockpiled overburden, and other nonpoint sources of pollution. The surface water section of Chapter 4 gives an in-depth description of potential surface water contamination. Any degradation of surface waters, especially an increase in heavy metal concentrations, would have serious adverse effects on all species using the affected aquatic habitats.

Reductions in streamflow either apart from or in conjunction with increased sediment loads would be detrimental to aquatic habitat. Of particular concern is the Belle Fourche watershed, where much of the regional development would take place, and Keyhole Reservoir. Keyhole Reservoir, although outside the area of analysis,

TABLE R4-7

HABITAT LOSS DUE TO REGIONAL DEVELOPMENT

	1980		1985		1990	
	Acres	% of Region	Acres	% of Region	Acres	% of Region
Grassland*	634	.53	1,061	.90	1,406	1.2
Sagebrush-Grass	23,048	.54	45,978	1.1	59,311	1.4
Ponderosa Pine	87	.02	146	.04	194	.06
Riparian	454	.20	786	.35	1,030	.45
Greasewood-Saltbush	192	.23	321	.38	425	.51
Aquatic (wetlands)	0	0	72	<.1	72	<.1
Other	178		207		207	
TOTAL	24,593		48,571		62,645	

* Figures include those for playa grassland, scoria grassland, and sandhills grassland.

** Figures include the sagebrush-grass type and silver sagebrush type. The acreage disturbed for human population increases (housing construction, etc.) was included in this type, since it is the most extensive type in the region and surrounds the population centers.

TABLE R4-8

SUMMARY OF BIG GAME HABITAT DISTURBED DIRECTLY AND INDIRECTLY BY MINING ACTIBITIES

	Mule Deer Yearlong (acres)	% of Regional Total	Pronghorn Yearlong (acres)	% of Regional Total	Pronghorn Winter/Yearlong (acres)	% of Regional Total
Coal Mining *	25,696		30,074		28,522	
Uranium Mining**	5,101		26,342		---	
TOTAL	30,797	1.7	56,416	2.7	28,522	2.6

* Includes the fifteen active or proposed coal mines discussed in this ES, and the proposed coal gasification plant. The areas considered were the boundaries of each mine permit area. Although the entire permit areas of these mines would not be disturbed, the new roads, fences, railroad spurs, noise, and increased human activity would have an adverse effect on the surrounding habitat.

** Figures from the Morton Ranch, Kerr-McGee, Highland, and Bear Creek uranium mines only. The indirect effects of these developments would be similar to those from coal mining.

TABLE R4-9

PROJECTED WILDLIFE LOSSES DUE TO POACHING AND VEHICLE KILLS

POACHING	1978 Known* Violations	1978 Actual** Violations	Projected Actual Violations*** 1980	1985	1990
Converse County****					
Total Big Game Violations	82	3,198	3,549	5,772	5,421
Pronghorn	19	739	820	1,333	1,252
Mule Deer	62	2,399	2,662	4,329	4,066
Elk	1	60	67	110	103
Campbell County					
Pronghorn	12	469	510	620	717
Mule Deer	39	1,522	1,656	2,014	2,327
Elk	1	38	42	51	59

VEHICLE KILLS*****	1977	1980	1985	1990
Converse County****				
Pronghorn	82	91	148	139
Mule Deer	113	126	204	191
Campbell County				
Pronghorn	1	1	1	2
Mule Deer	21	23	28	32

* No information was available for the species involved or for total number of animals involved in each violation in Converse County. Therefore it was assumed that the proportion of species lost was the same as in Campbell County. Figures for Converse County include only resident violations, committed outside the hunting season. Figures for Campbell County are for all game violations with no distinction made between resident and nonresident violators.

Sources for figures: personal communication, Russ Pollard and Lyn Bashford, Wyoming Game and Fish Department 1979.

** Actual violations were calculated using the Vilkitis formula (Bradley 1976).

$$\text{Maximum illegal kills} = \frac{\text{total known violations x } 97.5}{2.5}$$

Where 97.5 is the probability of nondetection and 2.5 is the probability of detection. This formula assumes (1) arrests are made in direct proportion to violations, (2) one arrest is made for every 200 violations, so probability of arrest is 0.5%, (3) probability of detection is 2.5%, and (4) maximum illegal kill is related to total arrests as the probability of not being detected (97.5%) is related to the probability of the violation being detected (2.5%).

TABLE R4-9
(cont'd)

PROJECTED WILDLIFE LOSSES DUE TO POACHING AND VEHICLE KILLS

*** $\frac{\text{1978 actual violations}}{\text{1978 human population}} = \frac{\text{1980, 1985, or 1990 projected violations}}{\text{1980, 1985, or 1990 human population}}$

**** All of Converse County.

***** 1977 figures for Converse County by personal communication, Dale Strickland, Wyoming Game and Fish Department 1979. 1977 figures for Campbell County were provided by personal communication, Tom Fanter, Wyoming Highway Department 1979, and reflect only collisions for which police accident reports were filed. The number of big game deaths due to collisions was probably much greater. Projected wildlife losses due to vehicle kills were calculated in proportion to human population.

TABLE R4-10

DIRECT BIRD POPULATION LOSSES DUE TO REGIONAL DEVELOPMENT

	1980	1985	1990
Nongame	98,165	192,625	248,975
Raptors	120	240	310
Game			
Waterfowl	0	1,910	1,910
Turkey	0	5	5
Sharp-tailed Grouse	805	1,610	2,075
Sage Grouse	1,500	2,990	3,855
Gray Partridge	130	220	290
Mourning Dove	2,525	4,980	6,425

Source: Derived from density figures in Chapter 2.

TABLE R4-11

BIRDS
SUMMARY OF POPULATION LOSS AND LOSS OF PROGENY

	1980	1985	1990
Nongame	113,870	377,545	687,170
Raptors	130	370	615
Game			
Waterfowl	0	3,170	4,220
Turkey	0	10	15
Sharp-tailed Grouse	905	2,815	4,930
Sage Grouse	1,690	5,235	9,155
Gray Partridge	165	550	1,090
Mourning Dove	2,955	10,060	18,440

Note: Net reproduction figures were obtained from the Wyoming Game and Fish Department (1978). Figures for all nongame birds were averaged to obtain a single figure. The same was done for all raptors. A fecundity figure for each species or group of related species of game bird was available.

The number of progeny produced per individual for each grouping (e.g. nongame raptors) was then calculated for periods of 1 (until 1980), 6 (until 1985), and 11 (until 1990) years. For example, if 1.4 new animals would be produced per individual in 10 years, .14 new animals would be produced per individual in 1 year, .84 in 6 years, and 1.54 in 11 years.

These figures were then multiplied by the number of individuals directly lost in that group (e.g., nongame raptors) to determine the number of progeny lost by each benchmark date.

Finally, the number of progeny lost was added to the number of animals directly lost to obtain the figures in the table.

Assumptions used:

1. A 50:50 sex ratio of males to females.
2. Average annual fecundity is the same for all habitat types for a given group of animals.
3. No mortality during reproduction.
4. Immigration equals emigration.
5. Habitat is utilized at its carrying capacity.

TABLE R4-12

DIRECT MAMMAL POPULATION LOSSES DUE TO REGIONAL DEVELOPMENT

	1980	% Regional Herd	1985	% Regional Herd	1990	% Regional Herd
Nongame*	750,185		1,486,475		1,919,105	
Furbearers/Predators**						
Beaver	90		160		205	
Muskrat	0		605		605	
Mink	30		50		65	
Coyote	115		250		325	
Bobcat	5		10		15	
Small Game						
Desert Cottontail	4,635		9,240		11,915	
Snowshoe Hare	210		365		480	
Big Game***						
Pronghorn	180	.37	355	.80	455	1.0
Mule Deer	105	.35	215	.74	280	.96
White-tailed Deer	1		1		2	

Source: Derived from density figures in Chapter 2.

* Including jackrabbits.

** No density data were available for badger and red fox, so no predictions of losses were made.

*** Figures derived by multiplying the mean density for all herd units by the amount of vegetative type lost. Only vegetative types considered important for each species' survival were used in the calculations (e.g., sagebrush and grassland types for pronghorn; sagebrush, ponderosa pine, and riparian types for mule deer; and riparian types for white-tailed deer).

TABLE R4-13

MAMMALS
SUMMARY OF POPULATION LOSS AND LOSS OF PROGENY

	1980	1985	1990
Nongame*	949,735	3,864,835	7,484,510
Furbearers			
Beaver	100	255	430
Muskrat	0	1,330	1,935
Mink	35	90	155
Coyote	130	460	825
Bobcat	5	15	30
Small Game			
Desert Cottontail	5,560	20,330	38,130
Showshoe Hare	250	805	1,535
Big Game			
Pronghorn	200	570	955
Mule Deer	115	345	590
White-tailed Deer	1	1	3

Note: Productivity figures were obtained from the Wyoming Game and Fish Department (1978). The method used to derive the figures on this table was the same as used for Table R4-11.

* Including jackrabbits.

is the major fishery serving the population of Campbell County. Any reductions in flow into the reservoir or increased sedimentation would reduce the quantity and quality of this major aquatic habitat.

Terrestrial

The amount of disturbance that would occur in each of the habitat types is described in Table R4-7. An estimated 92.2% of all surface disturbance would take place in the sagebrush-grass habitat type.

Sagebrush-grass. A total of 1.4% of the regional sagebrush-grass habitat would be destroyed by 1990. Disturbance of this habitat type would have a detrimental effect on several species of wildlife. Sage grouse and pronghorn depend on sagebrush for the major portion of their food, especially in the fall and winter seasons. The loss of large areas of sagebrush through the mining process, and subsequent reclamation to grasses, would effectively prevent these two species from reestablishing populations in the mined areas until sagebrush reinvades from adjacent undisturbed land.

Sage sparrows, Brewer's sparrows, mourning doves, and sage grouse all require sagebrush for nesting cover. These species would not nest in areas disturbed by mining and reclaimed to grass.

Although horned larks, lark buntings, western meadowlarks, vesper sparrows, and chestnut-collared longspurs would be displaced from the disturbed sagebrush areas, these species also nest in grassland types in the region and should be able to nest in the mined areas after reclamation to grass.

Mule deer would be affected due to loss of cover and food. The lack of cover following reclamation would make the reclaimed areas poor habitat for mule deer.

The most serious effect of the loss of sagebrush habitat and subsequent reclamation to grassland, would be the loss of vegetative diversity. Wildlife diversity depends on a diverse vegetative community. Sagebrush-grass communities in the region contain a variety of grasses, forbs, and shrubs. The diversity of cover and available food sources is much greater in an undisturbed sagebrush-grass community than in a reclaimed grassland community with only five to eight species. Vegetative diversity in reclaimed areas would be restored by the slow process of natural succession. The addition of fourwing saltbush to some seed mixtures would help mitigate the loss of sagebrush; however, saltbush is not a replacement for sagebrush. Furthermore, fourwing saltbush is a selenium accumulator and could potentially become toxic to wildlife browsing it. See Chapter 4, Vegetation.

Ponderosa Pine. Only a small fraction (.06% of the regional total by 1990) of ponderosa pine habitat type in the region would be directly disturbed by regional development. Overall, the effects of disturbance to species requiring this habitat should be minimal.

Riparian. The riparian habitat type supports the widest variety of mammals, birds, reptiles, and amphibians in the region. Loss of shrubs and trees would be detrimental to the numerous passerine birds which require heavy cover for nesting. In areas where large snags are removed, numerous species of birds, including several raptors, would be detrimentally affected. Mink and beaver would be affected by the loss of their habitat. Several small mammal species, especially shrews and voles, would be detrimentally affected. Direct losses to bird and mammal populations due to disturbance of riparian habitat would be second only to population losses in the sagebrush-grass type. A total of .45% of the riparian habitat in the region would be disturbed by 1990.

Sandhills Grassland. Small nongame mammals and a few songbird species would be adversely affected by disturbance to sandhills grassland habitat. Reclamation to grassland would probably create a habitat suitable for these species.

Greasewood-Saltbush. Losses of greasewood-saltbush habitat would amount to only a small fraction (.68% of the regional total by 1990) of all acreage that would be disturbed in the region. Species which inhabit this vegetative type also use other vegetative types in the region, so the loss of a small amount of greasewood habitat would not be significant to wildlife populations in the region.

Silver Sagebrush. For the purposes of analysis, the silver sagebrush habitat type has been included with the sagebrush-grass habitat.

Scoria Grassland. Disturbance to scoria grasslands would impact several species of small rodents and a few species of passerine birds. Reclamation of these areas to grassland should allow recolonization by the same species originally living there. The difference in the reclaimed habitat would be that most grasses currently used in the region for reclamation would differ from those originally present in this vegetative type. Losses of this type would amount to 5.1% of the regional total by 1990.

Playa Grassland. Disturbance of playa grasslands would have a minimal affect on regional wildlife populations, since only a small amount of this habitat type would be disturbed (0.8% of the regional total by 1990). Reclamation would include disposal of the highly alkaline playa sediments and replacement with topsoil more conducive to plant growth. Reclamation could improve the quality of the former playa grassland areas.

Water Sources

In addition to the loss of food and cover, many watering sources would be lost due to regional development. Table R4-4 in the surface water section of this chapter summarizes the water sources that would be lost. Data are lacking on how much wildlife habitat would become unusable because no water would be available. Numerous impoundments along ephemeral drainages would be destroyed by mining. Springs and potholes probably would be lost if the aquifers supplying them are severely altered.

Deepening of existing wells, drilling new wells in mined areas, and construction of new impoundments in reclaimed drainages would serve as mitigation for the loss of these water sources.

Topography

Topographic features such as cliffs, rock outcrops, cut banks, and rough hills would be destroyed by mining. Cliffs are important to many nesting raptors including golden eagles, prairie falcons, and red-tailed hawks. Rock wrens, canyon wrens, and cliff swallows also use rock outcrops or cliffs for nesting. Bank swallows use cut banks along old stream meanders for nesting. Cover for mule deer is enhanced by rough, broken topography. All of these species, and others, would lose these important components of their habitat due to regional development. Leaving large boulder piles in reclaimed areas would help to restore only some of these unique habitat features.

Indirect Habitat Loss

In addition to the areas that would be directly disturbed by mining, roads, railroads, powerlines, and new housing developments, habitat would be indirectly affected on adjacent areas, by human activity, noise, and fences. The development of a long, narrow band of such disturbed areas, stretching from approximately 10 miles north of Gillette to nearly 55 miles south of Gillette along the eastern edge of the coal seam is now occurring. This area would be 2 to 5 miles wide. It would effectively split much of the big game range in two. This would greatly limit east-west movement to preferred seasonal habitat areas. Thus, undisturbed habitat within the band of disturbance would become potentially useless to big game and other mobile terrestrial species. A summary of big game habitat disturbed directly or indirectly by various mining operations in the region is summarized in Table R4-8.

An unknown amount of fish and wildlife habitat would be destroyed as a result of increased regional population, most likely through increased off-road vehicle use and frequency of man-caused fires.

Population Loss

Animals inhabiting areas which are disturbed for mining or construction would be directly affected in one of two ways: they would either be killed immediately (e.g., reptiles, burrow-dwellers) or displaced to surrounding areas (e.g., large mammals, birds). Most of those displaced would not be able to compete successfully for food and territory, and would be lost.

Displacement and subsequent loss of wildlife would also occur in areas adjacent to development areas. The main causes of displacement and loss would be human activity and noise, which affect each wildlife species in various ways and to varying degrees. Even individuals of the same species can react differently to these two forms of disturbance. In general, the more sensitive and secretive a species, the farther it will be displaced by human activity. The area of displacement for each species is unknown, but this area may be as large or several times larger than the mine site or other development itself.

Increased human intrusion into normally undisturbed areas may stress some wildlife causing displacement and subsequent loss.

Displaced animals that move onto cultivated lands and damage crops may be shot or poisoned. The number of such occurrences is impossible to predict.

Carrying Capacity Loss

As habitat is destroyed, the area loses its carrying capacity, or ability to support fish and wildlife populations. All mineral development and related activity presently occurring or due to occur would cause a loss of carrying capacity in the region on 24,593 acres by 1980, 48,571 acres by 1985, and 62,645 acres by 1990. As stated above, reclamation would restore some habitat and thus some carrying capacity, but the number of species that would benefit would be few.

Little Thunder Creek, Caballo Creek, and Rawhide Creek would lose the carrying capacity on the disturbed sections of their streambeds. Increased siltation, leaching of toxic materials from exposed overburden, and possible contamination by sewage would all further lower the carrying capacity of these streams. Fish, aquatic reptiles and amphibians, and terrestrial species that prey on these aquatic species would be adversely affected. The complex natural communities found in undisturbed streams would likely take years to recover after the disturbed streambeds are reclaimed.

The numerous small stock reservoirs that would be lost would no longer support the often complex biota associated with them. Construction of new impoundments would not guarantee the reestablishment of similar biological communities.

Terrestrial habitats may also lose part or all of their ability to support wildlife populations due to the indirect effects of adjacent development activities.

Fish and Wildlife Population Losses

Fish

Nongame. The main nongame fish species that would be directly affected by regional development are sand shiner, fathead minnow, white sucker, and carp. The total population loss is not possible to calculate. Effects of this loss on wading birds, kingfishers, and game fish which prey on these nongame fish are also unquantifiable at this time.

Game. Populations of green sunfish and black bullhead inhabiting Caballo and Little Thunder creeks would be affected by mining.

The rainbow trout population of Caballo Reservoir, and the largemouth bass population of Reno Reservoir No. 1 would be destroyed by coal mining.

Endangered and/or Threatened Species. No known endangered or threatened fish species would be affected by development, since none is known to occur in the region.

Wildlife

An unknown quantity of wildlife would be lost due to the increased human population. There would be increased vehicle-animal collisions, poaching, wanton destruction, and predation by household pets. Table R4-9 summarizes the predicted loss of big game animals due to poaching and road kills in the region.

Birds. Birds would be subject to the aforementioned human-related impacts and to an unknown degree by collision with aerial obstacles such as power lines, by electrocution on power lines, and by impurities in settling and waste ponds.

Nongame. The main nongame bird species that would be affected by development are the sage sparrow, horned lark, Brewer's sparrow, lark bunting, vesper sparrow, and western meadowlark. Tables R4-10 and R4-11 present the estimated population losses due to regional development.

Raptors. Direct raptor losses are presented in Tables R4-10 and R4-11. Currently, it is not possible to predict indirect losses due to illegal shooting, disturbance of nesting sites, powerline electrocution, and other causes.

Game. Sage grouse and mourning dove populations would be the most detrimentally affected of all game bird populations in the region. Sage grouse would lose both nesting cover and their main food source on all disturbed sagebrush sites. Mourning doves would lose their nesting cover on the disturbed brush sites. Tables R4-10 and R4-11 present estimated losses for all game birds in the region.

Endangered and/or Threatened Species. There are three endangered species of birds which may occur in the region: the peregrine falcon, the whooping crane, and the bald eagle. It is possible that peregrine falcons migrate through the region; however, they probably would not be affected by development within the region. The whooping crane is a possible migrant, and would probably not be affected by regional development.

The bald eagle is normally only a winter resident of the Eastern Powder River Basin. The bald eagle usually nests near major drainages or large impoundments. The major drainages in the region have either small or intermittent flows and it is unlikely that these areas would be considered as preferred nesting habitat. Some of the eagles' winter hunting habitat may be lost due to development in the region; however, no federal action, including the site-specific proposal, is anticipated to have any adverse impacts on bald eagles or their wintering habitat.

Mammals.

Nongame. The major nongame mammal species that would be affected are the deer mouse, thirteen-lined ground squirrel, northern grasshopper mouse, meadow vole, and the least chipmunk. Small mammal losses are presented in Tables R4-12 and R4-13.

Furbearers. Estimated losses to furbearer populations in the region are presented in Tables R4-12 and R4-13. The loss of riparian and aquatic habitat would account for the losses to most furbearer populations. Loss of sagebrush habitat would account for most furbearing predator losses.

Game. Losses of big game are summarized in Tables R4-12 and R4-13. Indirect losses due to poaching and road kills are summarized in Table R4-9.

Endangered and/or Threatened Species. The black-footed ferret is the only mammal listed as endangered which may occur in the region. The preferred habitat of the black-footed ferret is prairie dog towns. Several prairie dog towns exist on or near the Wyodak and Rochelle coal mines. Since these towns are potential black-footed ferret habitat, they should be thoroughly investigated to determine if black-footed ferrets are present. In the event that ferrets are identified on the sites, immediate consultation with the U.S. Fish and Wildlife Service would be required under Section 7 of the Endangered Species Act.

Reptiles and Amphibians.

General. The main amphibian and reptile species affected by development would be the leopard frog, tiger salamander, boreal chorus frog, prairie rattlesnake, bull snake, eastern short-horned lizard, and the sagebrush lizard. Densities are unknown, so it is impossible to predict losses.

Endangered and/or Threatened Species. Development would not affect any threatened or endangered species, since none is known to occur in the region.

Economic Losses

Losses of wildlife in the region would also cause an economic loss to the region. Table R4-14 presents figures for the value of game animals and furbearers in the region. Big game hunting, mostly for pronghorn and mule deer, generated almost $10 million in 1977.

As populations of big game decline due to regional development, the Wyoming Game and Fish Department would also reduce the number of licenses available. A net loss in license revenues, as well as in the recreation resource, would occur.

Furthermore, the majority of big game hunters in the region are now from out of state. These hunters are willing to spend large amounts of money for out-of-state hunting licenses and tags, food, lodging, gas, and other necessities. With an estimated 57% increase in the region's population by 1990, demand for resident big game tags would greatly increase. Assuming a relatively stable number of tags available, a shift from mostly out-of-state tags to a majority of resident tags would result in a net loss of license revenues to the Wyoming Game and Fish Department, as well as income to retailers in the region.

The loss of other game and furbearing mammals due to regional development would also have an adverse economic impact, although it is rather small compared to losses of big game revenue. Table R4-15 summarizes the economic losses to the region due to wildlife loss. The increased demand for hunting recreation in the region may increase these values, but this is currently unquantifiable.

As habitat is disturbed, big game and other more mobile terrestrial species would be displaced to adjacent lands including agricultural lands. This could lead to in-

TABLE R4-14

ECONOMIC VALUES OF WILDLIFE IN THE EASTERN POWDER RIVER BASIN

	1975	1976	1977
Pronghorn*			
Harvest	18,261	19,284	16,142
Expenditures**	$2,502,205	$5,630,927	$5,472,618
Cost/Harvested Animal	$137	$292	$339
Mule Deer***			
Harvest	19,914	17,436	14,697
Expenditures**	$4,254,848	$5,102,330	$4,503,184
Cost/Harvested Animal	$213.65	$292.65	$306.40
Game Birds (cost/harvested bird or animal)			
Waterfowl			14.43
Sage Grouse			12.74
Sharp-tailed Grouse			17.72
Mourning Dove			6.81
Hungarian Partridge			23.68
Desert Cottontail			14.18
Showshoe Hare			48.06
Furbearers and Furbearing Predators (average pelt value)			
Beaver		14.00	
Muskrat		2.50	
Mink		9.00	
Badger		22.00	
Bobcat		230.00	
Coyote		40.00	
Red Fox		48.00	

Source: Wyoming Game and Fish Department 1977a.

* Figures from Powder River, Pumpkin Buttes, Bear Creek, and Lance Creek antelope herd units.

** Includes hunting license fees.

*** Figures from Pumpkin Buttes, Powder River, Lance Creek, West Bill, and Thunder Basin mule deer herd units.

TABLE R4-15

REGIONAL ECONOMIC LOSSES DUE TO LOSS OF GAME ANIMALS AND FURBEARERS
(1977 Dollars)

	1980	1985	1990
Small Game*			
Desert Cottontail	$ 1,064	$ 3,892	$ 7,299
Showshoe Hare	202	649	1,239
Furbearers and Furbearing Predators**			
Beaver	420	1,071	1,806
Muskrat	0	998	1,451
Mink	95	243	419
Badger***	---	---	---
Bobcat	345	1,035	2,070
Coyote	1,560	5,520	9,900
Red Fox***	---	---	---
Big Game****			
Pronghorn	20,340	57,969	97,123
Mule Deer	10,571	31,712	54,233
Game Birds*****			
Waterfowl	0	3,211	4,275
Sage Grouse	84	260	455
Sharp-tailed Grouse	58	180	314
Mourning Dove	1,890	6,433	11,792
Hungarian Partridge	3	9	18
TOTAL ALL GAME	$36,632	$113,182	$192,394

* Figures derived using number of animals and their progeny lost for each benchmark date, multiplied by the economic value of a harvested animal, assuming a 30% harvest, and weighing this figure by the rates of the number of hunter days spent in the region pursuing each species (Converse and Campbell counties) compared to the number of hunter days statewide.

** Figures derived using number of animals and their progeny lost for each benchmark date, multiplied by the economic value of a pelt, assuming 30% of these animals would be harvested.

*** No density figures were available for badger or red fox, so no losses could be calculated.

**** Figures derived using number of big game animals and their progeny lost by each benchmark date, multiplied by the 1977 value of a harvested animal, assuming a 30% harvest. Values include income to the state wildlife agency from hunting.

***** Figures derived using number of game birds and their progeny lost by each benchmark date, multiplied by the economic value of a harvested bird, assuming a 30% harvest. Each figure was also modified by multiplying it by the ratio of hunter days spent in the region (Converse and Campbell counties) pursuing each species compared to the number of hunter days spent statewide pursuing each species. Since mourning doves and waterfowl are migratory, the region was considered to be Converse, Campbell, Goshen, Platte, and Laramie counties.

creased crop damage. The economic loss this could bring about is currently unpredictable.

CULTURAL RESOURCES

Possible adverse effects of any development as listed by the Advisory Council on Historic Preservation consist of (1) destruction or alteration of all or part of a property, (2) isolation from or alteration of its surrounding environment, or (3) introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting (36 CFR 800.9). Possible effects are not limited to these criteria, and each project must be evaluated to determine effects to specific cultural resources. Cultural resource inventories and compliance required by the Historic Preservation Act of 1966 and Executive Order 11593 must be conducted before approval of any federal action; however, projects without federal involvement may not always be inventoried.

Salvage of cultural resources allows recovery of a portion of the scientific data present. However, current research methods and priorities may overlook sites or potential data within sites which would have been important to future research. Also, some sites not selected for salvage may be destroyed with recovery of only preliminary inventory data. These decisions may result in loss of valuable cultural resources.

Cultural resource inventories of planned or projected developments represent over 98% of the acreage inventoried in the region and account for over 95% of the known sites.

Coal development in the region has accounted for the largest percentage (94%) of cultural resource inventories. On a regional basis, 100% of the land approved for coal development has been inventoried.

Increased populations would cause accelerated unauthorized collection and vandalism of sites both on and outside the coal lease areas. Presently, very few sites have been identified which have not been damaged to some extent, and any increase in vandalism may impair their future research potential.

National Register

Numerous sites located both on and off the coal leases have either been declared eligible for nomination to the National Register or are believed may be eligible for listing. Impact to these sites would include the potential of total destruction as a result of planned mining. Excavation to recover data prior to mining would still eliminate these sites from the cultural resource data base of the region.

VISUAL RESOURCES

The cumulative effect of regional development, on visual resources would be a continuation of the gradual changes now occurring in the Eastern Powder River Basin. Municipal growth and mineral development in rural areas would result in actual loss of open space and would transform the region from a quiet, relatively uninhabited area to one busy with human and industrial activity.

The two predominant visual resource management classes of the region (III and IV) would be changed on a site-specific basis for the life of each mine, coal conversion plant, or uranium mill to Class V (interim classification for intrusion) by the alteration of landforms, and by the installation of mine structures and support facilities such as rail spurs and power lines. Reclamation would reduce the contrasts, and over the long term, restore the land to its original visual resource management class. Urban expansion and scattered housing and commercial development would permanently alter the visual character where they occur.

Scenic views would be changed. Indicators of this change would be roadside billboards, scattered housing tracts outside cities, and unregulated trash disposal and litter near plants and communities. Views of distant mountains may be obscured by haze resulting from increased vehicular and industrial emissions, and from fugitive dust. New vertical intrusions, such as coal storage silos and power plant stacks, would interfere with the natural landscape.

The greatest visual impacts would be experienced where the region's federal, state, and local roads provide visual access to the mineral development and urban areas.

RECREATION RESOURCES

The primary effect of total regional development would be increased numbers of people participating in and demanding recreation opportunities. The projected regional population increase by 1990 due to all development is 57% (see Table R1-3). Developed recreation areas and public lands in and surrounding the region would absorb additional use. Overcrowding would result, leading to vandalism and increased maintenance and repair costs. (Managing agencies such as the Forest Service and the Wyoming Recreation Commission do not plan development of new facilities, only expansion and maintenance of existing ones.) For those accustomed to solitude and wide open spaces, overcrowding would also reduce the quality of their recreation experience. Municipal facilities in particular would be inadequate to meet local needs; although the tax base would increase as a result of mineral development, there would be a lag between need and the availability of money for expansion of facilities. Finally, because of the small proportion of public land in the region available for recreation, overcrowding may increase the number of landowner conflicts with recreationists.

Cumulative regional mineral and municipal development would disturb approximately 62,645 acres by 1990. Most of this land is privately owned, but disturbance would remove some land currently available for recreation uses—mostly hunting or off-road vehicle use. Such

removal would further concentrate recreation use on remaining land.

Recreation Participation Data

Table R4-16 shows the projected trends in recreation participation for the region through the year 1990.

Hunting

Hunting would continue to be the major dispersed recreation activity in the Eastern Powder River Basin. Although wildlife populations statewide are projected to increase through 1990 (Wyoming Game and Fish Department 1975), loss of approximately 62,645 acres in the region due to all development would reduce game populations by 955 antelope and 593 deer by 1990. At the same time, hunting demand is expected to increase 151% by 1990. This would result in lower hunter success ratios, an increase in the amount of time required to get an animal, and possibly hunting restrictions such as smaller hunt areas and shorter seasons.

When human population and hunting pressure increase, some ranchers may make their property available to hunters as a business opportunity by charging "trespass"fees. However, other private land may be closed and posted, further reducing the recreation land base. The loss of private land for hunting could be more significant than the physical loss of land to mineral development.

Hunting quality in the region is not expected to return to its present level because of the long-term impact of regional development on wildlife populations and habitat (see Chapter 4, Wildlife). Furthermore, big game hunting (for the Wyoming resident) has traditionally been as much for the meat as the sport. Trespass fees or consistent lack of success would make hunting uneconomical. The decline in hunting quality and opportunity would cause resident and nonresident hunters to seek their recreation in other parts of the state.

Fishing

Two small reservoirs stocked with game fish would be directly affected by the regional development. The quality of the water and hence the fisheries throughout the region may be reduced by increased sediment levels or sewage (see Chapter 4, Water Resources and Wildlife). By 1990, the demand for fishing is expected to increase by 161%. The Wyoming Game and Fish Department (personal communication, Mike Stone 1977) estimates that fisheries such as Keyhole Reservoir could, if properly managed, absorb substantially more fishing pressure; however, as more people participate, the quality of the experience would diminish. This would be particularly true of the North Platte River impoundments and streams in the Laramie Mountains which are used by residents of the Cheyenne area and northern Colorado, as well as by residents of the region.

Winter Activities

Participation in skiing (downhill and cross-country) and snowmobiling would increase with population. Lack of sufficient snow base, suitable terrain, and access to public and private land would continue to cause residents of the region to seek winter recreation in the nearby mountain ranges. The Forest Service could expect the majority of this increased use to occur on national forest lands, resulting in management problems. Potential problems or magnification of existing problems include conflict between various groups (e.g., snowmobilers vs. cross-country skiers), litter, noise pollution, wildlife harrassment, and damage to the soils and vegetation. Because of limited amounts of public land in the region, more people with snowmobiles would be tempted to trespass on private lands causing landowner-recreationist conflicts.

Water-based Recreation

Boating, swimming, and water skiing would experience increased participation and demand (see Table R4-16). Overcrowding may occur, resulting in a reduction of the quality of recreation; management agencies such as the Wyoming Recreation Commission may find it necessary to place restrictions on the number of boats in order to provide for public safety.

Historical Interest/Sight-Seeing

Sight-seeing for scenery and historical interest would increase due to the increased number of people in the region. Energy development would have both positive and negative impacts on sight-seeing. Coal development and associated facilities would provide interesting and educational viewing for travelers on nearby roads and visitors to the mines themselves. Depending on the viewer's perspective, the mines and related development could provide man-made variety to an otherwise monotonous landscape.

From a negative standpoint, the mines and related development would be intrusions in a traditionally agricultural setting. Increased traffic and concentrated human activity would tend to displace wildlife away from roads used by sightseers.

Camping/Picnicking

Camping and picnicking would increase along with other activities. The brunt of the impact could be expected to occur at developed sites such as Keyhole Reservoir, Devils Tower National Monument, the North

TABLE R4-16

ESTIMATED RECREATION TRENDS, CAMPBELL AND CONVERSE COUNTIES
VISITOR DAYS

		1980	1985	1990	% Increase 1990 over 1975
Attending Athletic Events					
	Converse	21,000	24,000	27,000	
	Campbell	49,000	68,000	86,000	
		70,000	92,000	113,000	133%
Boating and Canoeing					
	Converse	11,000	15,000	18,000	
	Campbell	58,000	76,000	94,000	
		69,000	91,000	112,000	135%
Camping					
	Converse	66,000	78,000	90,000	
	Campbell	64,000	210,000	256,000	
		230,000	288,000	346,000	101%
Fishing					
	Converse	39,000	46,000	53,000	
	Campbell	54,000	80,000	106,000	
		93,000	126,000	159,000	166%
Golfing					
	Converse	20,000	23,000	26,000	
	Campbell	70,000	97,000	124,000	
		90,000	120,000	150,000	152%
Hiking					
	Converse	33,000	37,000	41,000	
	Campbell	60,000	78,000	96,000	
		93,000	115,000	137,000	92%
Hunting					
	Converse	21,000	25,000	29,000	
	Campbell	48,000	67,000	86,000	
		69,000	92,000	115,000	151%
Ice Skating					
	Converse	7,000	9,000	11,000	
	Campbell	17,000	21,000	26,000	
		24,000	30,000	37,000	106%
Picnicking					
	Converse	17,000	20,000	22,000	
	Campbell	73,000	88,000	103,000	
		90,000	108,000	125,000	74%

TABLE R4-16
(cont'd)
ESTIMATED RECREATION TRENDS, CAMPBELL AND CONVERSE COUNTIES
VISITOR DAYS

		1980	1985	1990	% Increase 1990 over 1975
Rodeos					
	Converse	30,000	34,000	39,000	
	Campbell	24,000	30,000	36,000	
		54,000	64,000	75,000	73%
Sight-Seeing and Pleasure Drives					
	Converse	68,000	81,000	95,000	
	Campbell	166,000	230,000	293,000	
		234,000	311,000	388,000	147%
Snow Skiing					
	Converse	5,000	7,000	9,000	
	Campbell	14,000	20,000	27,000	
		19,000	27,000	36,000	277%
Sledding and Tobogganing					
	Converse	3,000	4,000	4,000	
	Campbell	7,000	9,000	11,000	
		10,000	13,000	15,000	106%
Snowmobiling					
	Converse	5,000	6,000	6,000	
	Campbell	21,000	27,000	32,000	
		26,000	33,000	38,000	85%
Softball and Baseball					
	Converse	17,000	22,000	26,000	
	Campbell	42,000	53,000	65,000	
		59,000	75,000	91,000	106%
Swimming					
	Converse	32,000	35,000	38,000	
	Campbell	93,000	112,000	132,000	
		125,000	147,000	170,000	67%
Water Skiing					
	Converse	5,000	5,000	6,000	
	Campbell	16,000	21,000	26,000	
		21,000	26,000	32,000	118%
Tennis					
	Converse	4,000	5,000	6,000	
	Campbell	10,000	13,000	15,000	
		14,000	18,000	21,000	107%
Total		1,276,000	1,633,000	1,991,000	117%

Source: Derived from Wyoming Recreation Commission 1975

Platte reservoirs, and national forest lands. The resident would be competing with the nonresident for these resources. The various management agencies could find maintenance costs increased and the necessity to restrict and limit length and type of use. Conflicts between users would increase, and the quality of the experience for the recreationist who prefers solitude would be reduced.

Off-Road Vehicle (ORV) Use

The current proportion of people owning four-wheel drive vehicles and dirt bikes (35% and 12.5% respectively in Gillette) (University of Wyoming 1976) could be expected to continue as the population of the region grows. Areas of mining and municipal development would be removed from the available recreation land base. This means that landowner-recreationist conflicts, damage to vegetation and soil on existing public land, and annoying noise levels near residential areas may be greatly aggravated.

National forest lands and those administered by the Bureau of Land Management would bear the brunt of increased ORV use. The Bighorn National Forest has experienced a recent increase in ORV use and the number of law violations (personal communication 1978). Prevention of ORV damage would require increased supervision, education, and possible restrictions by all land management agencies.

Wilderness Values

The region's one nearby existing primitive area (Cloud Peak), and the five that have been identified as wilderness study areas or roadless areas, would be impacted by increased use. The number of visitor days devoted to hiking is projected to increase 72% by 1990 (Table R4-16). To prevent overuse and preserve wilderness character, the number of people using these areas may have to be limited.

AGRICULTURE

Taken together, all of the proposed energy developments including existing and proposed coal mines, uranium mining, oil and gas development, sand and gravel use, and resulting population increases would create large problems and dislocations for agriculture in the Eastern Powder River Basin of Wyoming.

All development on a cumulative basis would result in land use changes on approximately 62,645 acres by 1990. Of this amount, 32% (19,909 acres) would have been permanently removed from production by construction of plant facilities, residential areas, roads, and railroads. The remaining 42,736 acres would be in some stage of temporary disturbance or reclamation. Although lands would be reclaimed and eventually restored to agricultural use, the cumulative impacts of regional development would have detrimental and far-reaching effects on agricultural land use. The degree of impact on each ranch operation would vary greatly due to the location of the individual holdings (owned and leased) in relation to the proposed development.

(In the following sections on impacts most figures used are derived from Tables R1-2 through R1-6.)

Livestock Grazing

Direct loss of livestock forage would occur on 12,291 acres by 1980 through construction of plant facilities, residential and commercial areas, roads, and railroads. Acres of forage lost at the end of other benchmark periods would be 15,094 by 1985 and 19,909 by 1990. Grazing loss on this acreage would be approximately 2,686 animal units months (AUMs) by 1980, 3,018 AUMs by 1985, and 3,981 AUMs by 1990. This loss would last as long as the facilities, roads, or buildings exist and would be considered a long-term loss. (See Table R4-17.)

Reclamation of the mined land would be accomplished at approximately the same rate as acreage is disturbed; however, reclaimed areas are not expected to reach full production until 7½ years after seeding. The total acreage that would be reseeded but unable to support grazing would amount to 4,290 acres by 1980, 13,190 acres by 1985, and 20,000 acres by 1990. Temporary annual grazing loss on this acreage would be 858 AUMs in 1980, 2,638 AUMs in 1985, and 4,000 AUMs in 1990.

Impacts associated with population increases would occur. Recreation use could cause a nuisance problem (gates left open, livestock molestation, etc.) and might cause temporary impairment of livestock forage use. The proliferation of roads, access along with increased population, could result in increased vandalism of fences and other range facilities by outdoor recreationists. Rustling of individual animals and the molestation of grazing animals by off-road vehicle users could develop into serious problems, especially during calving and lambing.

The development of coal and uranium mines, oil and gas wells, power plants, a gasification plant, and the construction of facilities such as access roads, transmission lines, fences, a railroad, and rail spurs would lead to land separation, destruction of range allotment fences, pasture severance, crossing delays, and possibly alteration of present land ownership patterns. These developments would disrupt grazing use patterns, cause access problems to livestock watering areas and pastures, and increase the costs of caring for the livestock. Livestock losses would be expected to occur from obstacles created by additional fences and/or from collisions with vehicles.

Mine development could cause some obliteration of existing watering facilities for the duration of mining activities in the area. Mining of aquifers could dry up livestock water (wells or springs) in surrounding areas. (See Chapter 4, Water Resources.) This could result in nonuse of grazing areas if their locations are remote from remaining water sources.

Some grazing lands could be affected by increased erosion and sedimentation. Alteration of drainages by mining could cause accelerated erosion and headcutting

TABLE R4-17

SUMMARY OF PROJECTED LOSS OF AGRICULTURAL LAND AND PRODUCTION

	Total Land Area Permanently Removed From Livestock Forage Production (During Mine Life)	Annual Livestock Forage Lost Permanently (During Mine Life)	Land Removed From Crop Production (Based On Total Acres Disturbed)		Annual Hay Production Lost (Tons)			Annual Dryland Wheat Lost (Bushels)	Other Cropland Lost (Acres)	
Probable Level of Development	(Acres)	(AUMs)	(Acres) Dryland	(Acres) Irrigated	Dryland .78 Tons/Acre	Irrigated 1.62 Tons/Acre	Total Tons	18.6 Bushels/Acre	Dryland	Irrigated
1980 Total	12,291	2,686	600	164	291	192	483	3,636	91	39
1985 Total	15,094	3,018	1,072	278	448	322	770	6,035	131	65
1990 Total	19,909	3,981	1,439	372	583	425	1,008	7,957	163	86

in productive bottomlands, resulting in additional losses of livestock forage. Sedimentation of livestock reservoirs would cause loss of water through reduction of storage capacities.

Products of industrial activity, such as dust and noise, would discourage grazing in the proximity of such activity and render much land unavailable for grazing.

Dust and potentially toxic chemicals could adversely affect vegetation on and near the sites. As a result, both the productivity and palatability of vegetation could be reduced. This would, in turn, reduce the carrying capacity of undisturbed range and reclaimed land for domestic stock and wildlife. Although the acreages potentially affected are not precisely known, the most serious effects would probably be confined to a relatively restricted area downwind from and adjacent to the mine pit, haul and access roads, the rail spur, the coal loading facilities, or the plant site.

In addition to reduced carrying capacity, other direct effects of air pollutants on domestic and wildlife grazers would be possible. Chronic exposure to sulfur and nitrogen oxides can injure animals (University of Wyoming, Black Thunder Project Research Team 1976). Also, fugitive dust from overburden and coal may contain varying amounts of heavy metals. If concentrations of these heavy metals are high enough, chronic poisoning of animals via ingestion of contaminated vegetation and water would be possible. Such chronic poisoning from deposited heavy metals from industrial releases is well documented for cattle, horses, sheep, goats, and wildlife (ibid.). However, since neither the ground-level concentrations of gaseous pollutants nor deposition rates of particulate pollutants are known, the extent of any adverse effects on domestic and wildlife grazers cannot be predicted.

Physical separation of private land from adjoining federal grazing lease land, and division of grazing allotments by fenced rights-of-way may necessitate realignment of grazing allotment boundaries and users. Some loss of grazing use on federal lands would occur due to coal development activities and is included within the total projected loss of agricultural land and production.

Ranchers would have difficulty competing for the labor market as industrial wages increase.

Farming

Loss of nonirrigated farmland production is based on actual data submitted by the mining companies. A summary of the projected loss of crop production and farmland is contained in Table R4-17.

Possible impacts to irrigated croplands are anticipated to occur due to direct destruction of irrigated lands and the projected expansion of Douglas. Additional irrigated cropland may be affected by industrial water diversions and rights-of-way for roads, pipelines, railroads, and similar developments.

Displacement of wildlife from disturbed areas could lead to increased depredation of croplands. The significance of such occurrences cannot be determined.

Loss of productive irrigated cropland would also occur from conversion of irrigation water rights to industrial use. Additional purchases of irrigation water rights are presently being made throughout the Eastern Powder River Basin and the North Platte River system in Wyoming for use in coal development inside and outside of the region. Irrigation water is the major supply available to industry, although some plans are being developed to obtain water from deep wells.

Based on present information, water is already in short supply to many areas of irrigated croplands. Loss of water for irrigation could not be readily replaced from existing sources. Approximately 6% of the available irrigation water would be needed to satisfy the projected industrial and municipal needs by 1990. This represents the loss of a source of winter feed to the livestock industry equal to 67,200 tons of hay in an area with a winter feed deficit.

Irrigation systems themselves could be completely destroyed by mining activity.

Prime and Unique Farmland

It is possible that prime farmlands may be impacted by energy development. No formal designation of prime farmland in the region has occurred as yet. Agricultural lands on proposed surface mine sites will be analyzed on a site-specific basis to determine whether they meet the criteria for prime farmland as defined by the Surface Mining Control and Reclamation Act (see Chapter 2, Agriculture).

FOREST RESOURCES

No impact to marketable forest resources is expected from regional development activity.

MINERAL RESOURCES

Coal

The impact to coal resources of the region is the consumption of the resource. As of January 1, 1975, a cumulative total of 44.38 million tons of coal (Glass 1976) had been produced from the region. This is .06% of the minable and .2% of the strippable total original estimated coal resources of the region (see Table R2-24). Production figures for 1975-1977 are not available, but in 1978, production from the region is expected to be 44.6 million tons (see Table R1-1, Chapter 1) or .07% of the minable and .2% of the strippable coal resources of the region. In 1979-1980, cumulative production is expected to increase to 182 million tons or .2% of the minable and .8% of the strippable coal resources; in 1981-1985, to 749 million tons or 1% of the minable and 3.6% of the strippable coal resources; and in 1986-1990, to 886 million tons or

1% of the minable and 4% of the strippable coal resources of the region.

By 1990 a cumulative total of approximately 2 billion tons or more than 2.6% of the minable and 9.2% of the strippable coal resources of the region would have been consumed.

Other Mineral Resources

Coal development would not significantly impact the production of other mineral resources of the region.

Oil and gas is being produced from 166 fields in the region. Production has shown a decline since 1973, a trend that is expected to continue as the reserves are depleted.

Current and projected uranium mining would consume the uranium resources of the region. The Nuclear Regulatory Commission (1977) currently estimates the reserves in the Powder River Basin to be 25,400,000 tons of uranium ore. As discussed in Chapter 1, by 1990 it is anticipated that twelve mines will be providing a total of 13,000 tons per day of uranium ore, or 4,745,000 tons annually.

Sand, gravel, and scoria would continue to be quarried to meet demands for road and construction materials, and that resource would be gradually consumed.

TRANSPORTATION NETWORKS

Railroads

This section discusses the projected impacts of coal mining activities on rail traffic flowing through and out of the Eastern Powder River Basin.

Projected increases in coal and noncoal freight train traffic traversing the Eastern Powder River Basin are shown in Tables R4-18 and R4-19. Figure R4-11 displays coal train traffic over various segments of the Burlington Northern (BN) system.

At present, coal shipments from the Eastern Powder River Basin must be transported via the BN route through Donkey Creek and on to Alliance, Nebraska (see Figure R4-11). This track's current two-way maximum capacity of 40 to 65 trains per day must be upgraded by 1980 to accommodate the coal train traffic projected in Table R4-18.

However, by mid-1980, the rail strip currently under construction between Donkey Creek and Orin Junction, Wyoming, will be available to relieve the pressure on the present BN line. This link between the BN rail line and the Eastern Powder River Basin coal mining region will make an alternative traffic route for coal shipments available. Coal trains will be able to move south on the BN line toward Torrington, as well as north toward Donkey Creek. BN anticipates approximately half of the coal trains originating in the Eastern Powder River Basin would move north and about half south (personal communication, Jerrold G. Wood, Director of Public Works, Burlington Northern, Inc. 1978).

Anticipated impacts on communities located along the two routes are discussed in greater detail below. However, in general, most of the problems of pedestrian and vehicle access, isolation of parts of towns, and safety hazards (see Chapter 2) would be intensified. Trains would pass through these communities at a rate of over two an hour, causing railroad crossings between Donkey Creek and Alliance to be occupied between 3 and 6 hours per day, assuming train speeds vary between 10 and 50 miles per hour.

Northern Route

Sheridan and Gillette, two communities reviewed in Chapter 2, would not experience increased train traffic from the Eastern Powder River Basin coal mines, because most of the coal trains would connect with the BN route east of Gillette at Donkey Creek. Nevertheless, the previous vehicle and pedestrian transit problems described in Chapter 2 would continue unless grade separations within the town or rail bypasses around the towns are constructed.

In 1978, rail crossings in Newcastle are blocked from 1-1/4 to 2-1/4 hours daily by passing trains. Based on the train traffic projections in Table R4-19 and train speeds of 3 to 5 minutes per train, the grade railroad crossings would be blocked an average of 3-3/4 to 6-1/4 hours daily in 1980 and 3-1/4 to 5-1/4 hours daily in 1985 and 1990.

It is unlikely that Alliance would get much relief from coal-related rail impacts once the Donkey Creek to Orin Junction rail strip is opened. Due to train and pedestrian traffic around a rail car inspection yard and a diesel locomotive repair facility, a train speed limit of 10 to 15 miles per hour is enforced. Each coal train, therefore, would take at least 4 to 6 minutes to travel past each grade crossing. This means that grade railroad crossings would be blocked an average of 4-1/2 to 6-3/4 hours daily between 1980 and 1990. If the two grade separations currently under review are constructed, vehicle transit problems should be resolved. However, the west side of town, an area separated from the rest of town by the railroad tracks, would become even more isolated from downtown Alliance.

Grand Island would also continue to experience heavy impacts from the coal trains. This is due not so much to coal trains from the Powder River Basin as it is from the combination of freight traffic from the Powder River Basin and the Hanna Basin (south central Wyoming). Railroad tracks of two carriers of coal (BN and Union Pacific) intersect in this community. Unless a solution to alleviate traffic congestion at this intersection is agreed upon, serious problems should be anticipated. Emergency vehicles and school buses, already experiencing significant delays, would be blocked at crossing for even longer periods of time. Access to the Hall County Airport in the northeast section of town would become more of a problem.

TABLE R4-18

ANNUAL UNIT COAL TRAIN VOLUME

	1980 Number of Unit Trains*	1985 Number of Unit Trains	1990 Number of Unit Trains	Market Destination**
Buckskin Mine	200	400	400	Oklahoma
Existing Mines				
Operating Mines				
Wyodak	45***	45***	45***	South Dakota, mine mouth (Wyodak Power Plant)
Dave Johnston	0***	0***	0***	Mine mouth (Dave Johnston Power Plant)
Belle Ayr	2,000	2,000	2,000	Colorado, Texas, Indiana, Missouri, Kansas, Oregon, Arkansas
Cordero	2,000	2,400	2,400	Texas, Wyoming
Rawhide	900	1,200	1,200	Nebraska, Indiana
Black Thunder	1,370	2,000	2,000	Nebraska, Oklahoma, Texas
Jacobs Ranch	1,070	1,570	1,540	Arkansas, Louisiana, Oklahoma
Eagle Butte	1,320	2,000	2,000	Southern, Midwestern, and Ohio Valley states
Kerr-McGee #16	420	420	420	Unknown

TABLE R4-18
(cont'd)

ANNUAL UNIT COAL TRAIN VOLUME

	1980 Number of Unit Trains*	1985 Number of Unit Trains	1990 Number of Unit Trains	Market Destination**
Environmental Statement in Progress				
Caballo	300	700	1,200	Unknown
Coal Creek	400	1,000	1,000	Unknown
East Gillette	400	1,100	1,100	Arkansas, Louisiana
Rochelle	0	0***	0***	Wyoming
Pronghorn	350	500	500	Unknown
Total	10,775	15,335	15,805	

1980 daily average = 10,775 trains per year ÷ 365 = 29.5 trains per day eastbound (loaded)
29.5 trains per day westbound (empty)
1985 daily average = 15,335 trains per year ÷ 365 = 42.0 trains per day eastbound (loaded)
42.8 trains per day westbound (empty)
1990 daily average = 15,805 trains per year ÷ 365 = 43.3 trains per day eastbound (loaded)
43.3 trains per day westbound (empty)

Source: Table R1-2.

* A unit coal train usually consists of 100 coal cars and 5 diesel units. Each car carries 100 tons of coal.
** Based on Western Oil Reporter February 1978.
*** This number does not represent full transport of the mine production by unit trains. Coal consumed at mine mouth is generally transported short distances by truck or private rail.

TABLE R4-19

DAILY TRAIN VOLUME PROJECTIONS FOR THE REGION

Train Type	1980* Number of Trains**	1980* Percent of Total	1985 Number of Trains**	1985 Percent of Total	1990 Number of Trains**	1990 Percent of Total
Northern Route						
Total Coal Trains:	67.9	91.9	56.9	90.5	58.2	90.6
Buckskin Mine***	1.1	1.5	2.2	3.5	2.2	3.4
Eastern Powder River Basin Coal Trains***	55.8	75.5	43.7	69.5	45.0	70.1
"Other" Coal Trains****	11.0	14.9	11.0	17.5	11.0	17.1
Non-coal Freight Trains*****	6.0	8.1	6.0	9.5	6.0	9.5
Total Coal and Non-coal Freight Trains	73.9	100.0	62.9	100.0	64.2	100.0
Southern Route						
Total Coal Trains:	0	0	43.7	84.5	45.0	84.9
Buckskin Mine***	0	0	0	0	0	0
Eastern Powder River Basin Coal Trains***	0	0	43.7	84.5	45.0	84.9
"Other" Coal Trains	0	0	0	0	0	0
Non-Coal Freight Trains	8	100.0	8.0	15.5	8.0	15.1
Total Coal and Non-Coal Freight Trains	8	100.0	51.7	100.0	53.0	100.0

* Train traffic expected on the Burlington Northern route in early 1980 before the Donkey Creek to Orin Junction rail strip is completed. If the rail strip were completed in 1980, about half of the coal trains originating in the Eastern Powder River Basin (i.e., 28.4 trains) would move south toward Orin Junction.

** Includes both loaded and empty train traffic.

*** See Table R1-2.

**** Burlington Northern estimate of coal trains in Gillette in 1982, personal communication, Jerrold G. Wood, Director of Public Works 1978.

***** Burlington Northern freight traffic estimate for the Donkey Creek to Edgemont rail segment in 1978 and 1982, personal communication, Jerrold G. Wood, Director of Public Works 1978.

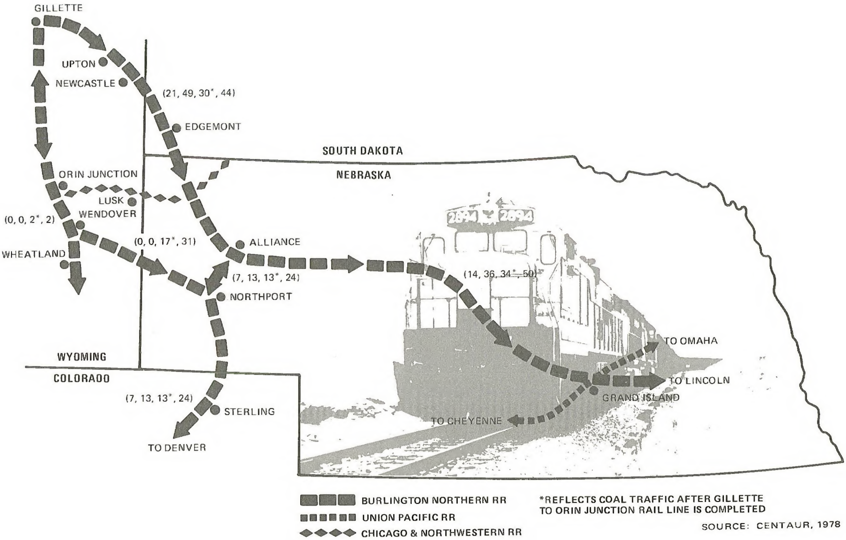


Figure R4-11

ESTIMATED DAILY COAL TRAIN TRAFFIC (1978, 1980, 1980*, 1985/1990)

Southern Route

The opening of the rail line from Donkey Creek to Orin Junction and the movement of coal south on the BN line would expose communities not previously affected by coal trains to heavy train traffic.

By 1985 or 1990, some of the coal trains may be routed over the Chicago and North Western line (Figure R4-11) from Orin Junction through Lusk. The extent the route would be used, if at all, is still very indefinite. Considerable upgrading of this track would be necessary before any coal traffic could travel over this railroad. Due to the uncertainty surrounding this route, it was not included in our projections of rail traffic. However, if coal traffic were eventually routed over this rail line, a grade separation would be needed in the community of Lusk. (Personal communication, John Lane, Wyoming Highway Department 1978).

The community of Torrington was contacted about anticipated impacts. Due in part to the advance planning that has been possible, highway-railroad crossings are being upgraded and additional protective devices are being installed where needed. The improvements will permit faster train speeds, thus reducing the delay time at railroad crossings when trains travel through the town. No grade separations are currently planned. However, if train traffic increases much beyond 22 trains per day a structure separating a major highway from the railroad tracks would be needed (personal communication, Keith Newman, Torrington Chamber of Commerce, and John Lane, Wyoming State Highway Department 1978).

From Torrington, coal trains would continue east to Northport, Nebraska, thence east to Alliance or south to Sidney, Nebraska. While trains would bypass the town of Northport, they would pass through Sidney, causing vehicle delays at 10th and 13th streets. Beyond Sidney, in Sterling, Colorado, coal train traffic would merge with Union Pacific freight traffic. Sterling, therefore, represents a point, like Grand Island, where rail traffic impacts of Eastern Powder River Basin coal would become indistinguishable from other rail transport traffic. (The Colorado Department of Highways commissioned a study of the impacts of coal trains on communities in Colorado. The resulting report *(Coal Train Assessment, Final Report*, December 1976) recommended projects such as grade-separated crossings at two sites in Denver, three in Englewood, three in Littleton, two in Colorado Springs, and one in the southern suburbs of Colorado Springs. The report also suggested further study of impacts in the Littleton area, where there are currently no grade-separated crossings and the railroad bisects the business district and arterial streets. It also suggested that bypasses of Walsenburg might be beneficial.)

Highways

Based on the 1975 rate of vehicle registration of 945 per 1,000 population, the projected number of registered motor vehicles in the eight northeastern counties of Wyoming would be 154,000 in 1980, 180,100 in 1985, and 198,300 in 1990. Increased road use would mean increased road maintenance and vehicle accident occurrences. Increased vehicle use would also result in increased noise levels, decreased air quality (due to dust and exhaust fumes), and increased wildlife and domestic animal road kills. (See Chapter 4, Air Quality and Wildlife.)

The roads that would be impacted the most are State Highways 59 and 387, U.S. Highway 14/16, the Reno Junction-Clareton Road, and Interstates 90 and 25. Substantial maintenance and upgrading of Highways 59 and 387 could be required to accommodate the projected traffic flow increases. The county road system would also be impacted by increased traffic flow.

See Chapter 8, Low-Level Scenario, for a description of highway improvements already planned.

Air Service

All seven commercial airports in northeastern Wyoming would experience increased passenger and freight traffic. The greatest impact, however, should occur at the Gillette-Campbell County Airport. There is a commuter airline service for the community of Gillette with daily flights to Casper, Douglas, Cheyenne, and Denver. However, no major commercial airlines serve Campbell and Converse counties, the closest commercial airline services being in Sheridan and Casper; this would mean increased use of the latter airports due to spillover effects from Campbell and Converse counties.

Total operations (takeoffs and landings) at the Gillette-Campbell County Airport in 1976 were 75,000 (personal communication, Sam Stafford 1977). Assuming use increases at the same rate as population, total operations would be approximately 204,740 by 1990. Another indicator of use is aviation fuel consumption. Whereas aviation fuel consumption has increased 30% each of the last 2 years in the state of Wyoming, it has increased 50% each of the last 2 years at the Gillette-Campbell County Airport. This emphasizes the particularly heavy impact which the Gillette-Campbell County Airport is already experiencing.

The Gillette-Campbell County Airport already is facing difficulties in meeting present demands on its facilities. Presently many passengers that want to land at Gillette are forced to land at either the Natrona County International Airport or the Sheridan County Airport and then rent cars and drive to the Gillette area. If major commercial airlines do begin to operate out of the Gillette-Campbell County facility, "noise pollution"in Gillette could become a problem.

Growth in air traffic at the Natrona County International Airport is shown in Table R4-20. Total operations have increased by 39,968 (71%) in the 4-year period from 1973 to 1977. Passenger and air freight totals show similar large increases from 1973 to 1976 of 53% and 26% respectively. By 1990, total operation at Natrona County International Airport would be 155,866 and total freight 6,464,841 pounds. This would mean a 39% increase in both total operations and in total freight from

TABLE R4-20

NATRONA COUNTY INTERNATIONAL AIRPORT

Year	Air Carrier*	Itinerate**	Local***	Total	Passengers****	Air Freight***** (Total pounds)
1973	10,058	28,452	17,542	56,052	132,991	2,424,747
1974	10,315	35,348	25,180	70,843	165,983	2,836,630
1975	10,519	37,418	19,394	67,331	185,113	2,997,030
1976	9,851	47,244	24,641	81,736	203,523	3,059,782
1977	9,548	53,978	32,494	96,020	234,026	3,977,716
1980	12,775	71,540	42,582	126,897	310,004	5,263,272
1985	14,147	79,226	47,158	140,531	343,317	5,828,839
1990	15,691	87,872	52,303	155,866	380,776	6,464,841

Source: Personal communication, John Martin 1977.

Note: Projections for 1980, 1985, 1990 are based upon population projections for Natrona County and assume the ratio between population in Natrona County and air operations in 1977 will remain the same in the future.

* Western and Frontier airlines
** Takeoff or landing by non-Casper-based aircraft
*** Takeoff or landing by Casper-based aircraft
**** Includes passenger arrivals and departures
***** Includes air freight received and sent

1977 to 1990. In general, the Natrona County International Airport has excellent air facilities, not only to meet present but also future demands. Expansion and improvement have occurred regularly. Recently the runways were improved, and a planned $2 million terminal expansion began in 1978. The only problem area is the water system, which is old and inadequate for both present and future needs (personal communication, John Martin 1977).

Increases in air traffic at the various airports could necessitate (1) possible additions to runways, and other facilities at the airports; (2) possible future relocation of the Gillette-Campbell County Airport and/or Converse County Airport; (3) increased potential for midair collisions and takeoff and landing accidents; (4) employment of additional personnel (flight service, maintenance, etc.); (5) increased noise levels; and (6) if services and facilities are improved and keep up with demand, improved air services for the region and the state of Wyoming. There is at present insufficient information available to predict potential magnitude of these impacts.

See Chapter 8, Low-Level Scenario, for a description of other regional airport improvements already in progress.

Bus Lines

As populations increase, so would the use of bus services; however, the two bus companies servicing this region (Continental Trailways and Central Wyoming Transportation Company) anticipate no real problem in meeting future demands (personal communication, Ed Shilling, Trailways 1977).

Pipelines

The proposed Panhandle Eastern Gasification Plant would require a 24-inch, 475-mile gas line. About 20 to 30 miles of this line would be in the Eastern Powder River Basin and would require 200 to 350 acres of land. It is expected that the line to supply water to the gasification plant would be 10 to 30 miles long and would require an additional 100 to 200 acres (Harbridge House 1976).

Additional pipelines might be necessary to handle increased natural gas or water needs for impacted communities. At present there is insufficient information to determine the magnitude of this possible demand.

Telephones

As population increases, so would the use of telephone services. By 1985, it is projected that the number of telephones in Campbell and Converse counties would double. However, a recently installed, very modern system in Gillette should handle anticipated future growth without any problems (personal communication, Ann Holmberg 1977). If necessary, a similar system could be installed in the Douglas-Glenrock area to handle service demands.

Electric Transmission Lines

Tri-County Electric Association has proposed a 230-kv transmission line to be built in cooperation with Pacific Power and Light Company (PP&L) from the Dave Johnston Power Plant near Glenrock to the area of Wyodak (with PP&L handling the Converse County portion, and Tri-County Electric Association the Campbell County portion). This 120-mile line could be constructed by 1980, if demand is sufficient, and it would occupy approximately 3,000 acres. When the line is built depends largely upon levels of regional development as its main function would be to supply power to coal mining operations. Additional lines could be necessary in the future to service energy-related needs.

SOCIOECONOMIC CONDITIONS

Sociocultural Impacts

Introduction

It is anticipated that traditional life-styles, attitudes, and values in northeastern Wyoming would continue to change, and that these changes would be reflected in a changing psychological environment. Any additional regional development that is unplanned in terms of avoiding and mitigating potential socioeconomic impacts would further complicate an already difficult situation.

Life-Styles, Attitudes, and Values

Traditional regional agrarian attitudes and values common in northeastern Wyoming are being challenged by characteristics (attitudes and values) related to boomtown conditions and by the process of industrialization. The potential for conflicts between the two sets of attitudes and values is great. (A detailed discussion of typical regional attitudes and values appears in Chapter 2, Socioeconomic Conditions.)

Many of the long-time residents may find population growth and the change to an industrial economic base to be frustrating--often disturbingly different from the small agricultural community life-style with which they are familiar. Often in boom employment situations, although many local residents do benefit directly through employment, there exists a segment of the population which for one reason or another (such as age or lack of specific skills) is unable to benefit through employment, but must either suffer the associated higher costs of the boom or be forced out of the area. Ranchers suffer in at least the short run, as the boom drives up their costs and reduces the availability of labor. There often is an associated increase in their land prices, but this can only help by

giving the rancher more equity to borrow against or help his cash flow if he sells some of his land.

Newcomers, on the other hand, may find it difficult to fit into the established patterns of activity and the lifestyles of the long-time residents. Many newcomers, especially the well educated, may dislike the isolation, the lack of services and culture, and the unfriendliness of some of the long-time residents. If local industry and services (such as medicine, housing, education, and recreation) cannot keep pace with energy industry growth, social difficulties in the region would be magnified for both current and new residents.

Psychological Impacts

Boom-town conditions may cause psychological impacts on some of the people within the region. Resulting problems include alcohol and drug abuse, single-car accidents, absenteeism from work, divorce, crime and delinquency, mental depression, suicide, and wife and child abuse. For example, the 1975 divorce rate in Campbell County was 42% higher than the state average, and in 1977, county child abuse case loads were the highest in the state (personal communication, Dr. Weiz, Northern Wyoming Mental Health Center 1977). Higher mental health hospital admission rates apparently correlate with those Americans that have migrated into one state from another (Locke and Duvall 1961). An estimated 70% of the construction workers in Campbell County are migrants from other states.

Data available from other counties in the region reveal similar trends. In Converse County, reported cases of child abuse nearly tripled between 1976 and 1978, from 37 cases to 102. The need for foster or group home placements for children and adolescents increased from 20 such placements in 1974 to 68 in 1978 (personal communication, Wally Wolf, Director of Vocational Rehabilitation, Douglas 1978).

Psychological impacts can be reflected in lower corporate profits and regional coal production due to loss of worker productivity. In a study of boom towns by Gilmore (1976), it was noted that coal output declined 25% to 40% in Rock Springs, Wyoming, between 1972 and 1974; in large part, this was attributed to a drop in worker productivity due to a high worker turnover rate and the subsequent need to train new employees.

The importance of human communication and interaction to mental health has long been accepted. Most new migrants to the region tend to be temporarily isolated from the general community, but isolation tends to severely impact families of construction and some mining workers who settle in mobile home parks.

> Boomtowns are often not good places for wives. The wives of construction workers are mostly living in "aluminum ghettos"on the fringe of urban settlement. There are few jobs for women in construction work, and the support jobs don't increase as fast as the population. Activities—educational, social, and cultural—are limited, and there may be "cultural shock"for those who moved from large urban centers. Schools may be crowded and recreation limited for their children (Department of Housing and Urban Development 1976, p. 25).

The lack of local public transportation and limited mass transportation to regional trade centers increases family isolation.

Presently there is help available in Campbell County for mental health problems. In Gillette, the Campbell County Office of the Northern Wyoming Mental Health Center has been helping people with their problems and working with the community to improve the mental health climate since 1967. The center is presently staffed by four full-time mental health clinicians. Dr. Weiz, the coordinator for the center, feels that the center needs an additional three or four mental health clinicians, particularly in the area of crisis intervention (personal communication 1977). The office provides 24-hour telephone crisis service to connect a person in distress with one of the mental health clinicians. This "outreach"service is intended to counter the traditional "go it alone"western attitude that is often a barrier between those who need help and those who offer it.

If the local population doubles in the next 15 years, as is projected, mental health care would be inadequate. The degree of the population impact would be expected to create major problems in the short run; however, in the long-run, the size of the problem would depend upon how much of the mental health facilities are expanded and improved.

Economic Impacts

Introduction

Since many of the economic impacts of regional development in the Eastern Powder River Basin would affect neighboring counties, the economic analysis has been developed on the basis of an eight-county region. The eight-county region includes Campbell and Converse counties, as well as the neighboring counties: Crook, Johnson, Natrona, Niobrara, Sheridan, and Weston.

Additional information specific to Campbell County and Gillette can be found in Chapter 3, Socioeconomic Conditions, of the site-specific analysis.

Population

Table R4-21 contains local and regional cumulative population projections. These projections were made using the model developed by the Water Resources Research Institute of the University of Wyoming. Where feasible, population projections generated by the model have been "benchmarked"to current population estimates furnished by individual communities. The projections in Table R4-21 foresee a continued rapid growth in the population of Campbell County and Gillette between 1978 and 1990. During this period, Campbell County's population is anticipated to grow from 26,080 to 34,583, an average annual rate of change of 3.5%. Gillette,

TABLE R4-21
CUMULATIVE POPULATION PROJECTIONS, 1978-1990

County City	1978	1980	Annual Rate of Change* 1978-1980	1985	Annual Rate of Change* 1980-1985	1990	Annual Rate of Change* 1985-1990	Annual Rate of Change* 1978-1990
Campbell	26,080	28,222	(4.0)	34,761	(4.0)	39,583	(2.9)	(3.5)
Gillette	20,450	22,353	(4.5)	28,383	(4.9)	33,705	(3.5)	(3.0)
Other Areas	5,630	5,869	(2.1)	5,878	**	5,878	**	(0.4)
Converse	11,700	13,021	(5.5)	21,114	(10.2)	19,811	(-1.3)	(4.5)
Douglas	7,500	8,375	(5.6)	15,055	(12.4)	13,680	(-1.9)	(5.1)
Glenrock	2,700	3,137	(7.8)	4,542	(7.7)	4,614	(0.3)	(4.6)
Other Areas	1,500	1,514	(0.5)	1,517	**	1,517	**	(0.1)
Crook	5,148	5,438	(2.8)	6,319	(3.1)	6,837	(1.6)	(2.4)
Moorcroft	1,200	1,486	(11.3)	2,361	(9.7)	2,879	(4.1)	(7.6)
Other Areas	3,948	3,952	**	3,958	**	3,958	**	**
Johnson	6,803	6,862	(0.4)	7,212	(1.0)	7,624	(1.1)	(1.0)
Buffalo	4,400	4,455	(0.6)	4,799	(1.5)	5,211	(1.7)	(1.4)
Other Areas	2,403	2,407	**	2,413	**	2,413	**	**
Natrona	73,588	74,965	(0.9)	82,882	(2.0)	92,079	(2.1)	(1.9)
Casper	50,579	51,116	(0.5)	54,203	(1.2)	57,789	(1.3)	(1.1)
Other Areas	23,009	23,849	(1.8)	28,679	(3.8)	34,290	(3.6)	(3.4)
Niobrara	3,020	3,045	(0.4)	3,133	(0.6)	3,219	(0.5)	(0.5)
Lusk	2,000	2,021	(0.5)	2,103	(0.8)	2,189	(0.8)	(0.8)
Other Areas	1,020	1,024	**	1,030	**	1,030	**	**
Sheridan	22,501	23,713	(2.7)	27,347	(2.9)	31,666	(3.0)	(2.9)
Sheridan	13,400	14,608	(4.4)	18,230	(4.5)	22,549	(4.3)	(4.4)
Other Areas	9,101	9,105	**	9,117	**	9,117	**	**
Weston	6,932	7,493	(4.0)	8,315	(2.1)	8,976	(1.5)	(2.2)
Newcastle	3,455	4,012	(9.8)	4,828	(3.8)	5,489	(2.6)	(4.0)
Other Areas	3,477	3,481	**	3,487	**	3,487	**	**
Region	155,772	162,759	(2.2)	190,583	(3.2)	209,795	(1.9)	(2.5)

Source: University of Wyoming 1978.
* Average rate of change compounded annually.
** Average rate of change less than 0.1 %.

meanwhile, should grow from 20,450 to 33,705 inhabitants (an average 3.0% annual increase). Both the county and Gillette would experience their most rapid rate of annual population increase between 1980 and 1985 (4.0% and 4.9% per year respectively), declining gradually thereafter.

Converse County and the towns of Douglas and Glenrock would experience major population growth during the period under study, largely as a result of the projected coal gasification plant to be built northeast of Douglas. This population boom is expected to peak around 1985, when Converse County would have a population of 21,114 and Douglas would have 15,055 inhabitants. Thereafter, Converse County and Douglas both would face a decline in population as the coal gasification plant's large construction work force is disbanded and replaced with a smaller operating staff. Glenrock, where fewer of the gasification plant construction workers would live, would experience a somewhat slower population growth rate (5.2% annually between 1978 and 1990), but avoid a drop in population after the gasification plant is completed in 1985-1986. However, population growth in Glenrock would level off at only 0.3% annually between 1985 and 1990.

Crook and Weston counties, particularly the towns of Moorcroft (Crook) and Newcastle (Weston), would also experience significant population growth, since as much as one-third of the permanent work force in the Campbell and Converse County coal mines are expected to reside in those cities and commute to work. Like Campbell and Converse counties, the most rapid rate of increase in Moorcroft's and Newcastle's populations would occur between 1978 and 1980.

The continued steady expansion in the population of Casper (Natrona County) is attributable mainly to Casper's status as a regional trade center. Continued growth in the regional economy, mostly fueled by coal exports, would continue to enhance Casper's trade center status.

Sheridan County, particularly the city of Sheridan, would experience significant population growth between 1978 and 1990, although the local population growth rates would be slower than in Campbell and Converse counties and the town of Moorcroft. Population growth in Sheridan County would result primarily from a continuing influx of coal mine workers from neighboring areas of Montana, as well as from enlargement of Sheridan's present role as a secondary regional trade center.

After a short period of relatively rapid population growth rate (5.6% annually) between 1976 and 1978, population growth in Johnson County is anticipated to diminish to an average rate of only 1.0% annually between 1978 and 1990. Niobrara County is likewise expected to experience only nominal growth (0.5% annually).

Employment

Table R4-22 contains cumulative employment projections for the eight-county region. These projections are expressed in terms of the number of persons holding jobs, rather than the number of jobs, eliminating double-counting of persons who hold more than one job simultaneously. Summarizing, business and consumer services would remain the predominant source of employment through 1990, although their percent share in total employment should decline somewhat during this period (i.e., from 50.0% to 46.5%). Primarily under the influence of coal development, minerals extraction is projected to increase its relative share in total employment between 1978 and 1980 (i.e., from 17.8% to 19.1%). While declining in its relative share of total employment after peaking in 1980, mining employment is projected to show continued moderate growth in absolute terms through the end of the decade. Construction employment should peak in 1985 due to the projected construction of a gasification plant in Converse County, then decline in both relative and absolute terms through 1990. Among the other sectors of the regional economy, agriculture should continue to decline in relative importance as a source of employment through 1990, from 3.3% in 1978 to 2.5% by 1990. Manufacturing is projected to decline from 5.4% to 4.9% of total employment during the period under study. Railroad employment would increase slightly, from 0.4% to 1.0% of regional employment. Government employment should show considerable absolute and relative increases (from 14.9% to 18.7% of total employment).

These projected regional developments would be mirrored to varying degrees among the individual counties. In most counties, business and consumer services would occupy a less important role in the local economy than they do in the region as a whole; this discrepancy is attributable to the preponderance of business and consumer services in Casper and Sheridan, which account for most of the region's employment in these sectors. However, business and consumer services are projected to remain the most important source of employment in every county except Converse and Crook, where this sector would be supplanted by mining before 1985. Campbell and Johnson are the only counties in which construction is projected to consistently exceed 10% of total employment. However, due to the construction of a gasification plant northeast of Douglas, construction would peak sharply at nearly 30% of total Converse County employment in 1985. Manufacturing employment would be concentrated in Natrona County throughout the period until 1990, offsetting the relatively low levels of manufacturing employment in the other counties. Government/education would be a major source of employment in all counties, particularly Sheridan (where it constitutes between one-fourth and one-third of county employment in the period under study). Finally, agricultural employment would show a steady decline in relative terms in all counties through 1990.

Income

Table R4-23 contains cumulative earnings projections for the eight-county region. Total earnings in the region would be expected to rise from $631.1 million in 1978 to $1,214.7 million in 1990, an increase of 92.5%. (All figures are expressed in 1975 equivalent dollars.) It is antici-

TABLE R4-22

CUMULATIVE EMPLOYMENT PROJECTIONS BY SECTOR

EIGHT-COUNTY REGION
1978-1990

	1978*		1980		1985		1990	
	No.	% Total	No.	% Total	No.	% Total	No.	% Total
Agriculture	1,669	(3.3)	1,685	(3.1)	1,698	(2.7)	1,698	(2.5)
Minerals Extraction	9,064	(17.8)	10,935	(19.9)	12,045	(19.0)	12,882	(19.1)
Construction	4,167	(8.2)	4,633	(8.4)	6,249	(9.8)	4,843	(7.2)
Manufacturing	2,764	(5.4)	2,867	(5.2)	3,101	(4.9)	3,337	(4.9)
Railroads	182	(0.4)	321	(0.6)	608	(1.0)	660	(1.0)
Business/ Consumer Services	25,408	(50.0)	26,289	(47.9)	29,394	(46.3)	31,391	(46.5)
Government/ Education	7,575	(14.9)	8,093	(14.8)	10,422	(16.4)	12,624	(18.7)
Military	22	**	22	**	22	**	22	**
Total***	50,851	100.0	54,845	100.0	63,539	100.0	67,457	100.0

Source: University of Wyoming 1978.

* 1978 employment figures represent first quarter employment only. Unlike 1978 population estimates, which have been benchmarked to current population estimates provided by local communities, differing definitions of employment utilized by the University of Wyoming's model and the Wyoming Employment Security Division precluded using state employment data as a benchmark for model-generated employment projections.

** Less than 0.1%.

*** Totals may not add to 100.0% due to rounding.

TABLE R4-23

CUMULATIVE EARNINGS PROJECTIONS BY SECTOR

EIGHT-COUNTY REGION
(MILLIONS OF 1975 DOLLARS)

	1978*		1980*		1985*		1990*	
	Dollars	% Total	Dollars	% Total	Dollars	% Total	Dollars	% Total
Agriculture	15.2	(2.4)	17.7	(2.4)	18.8	(1.9)	19.9	(1.6)
Minerals Extraction	142.2	(22.5)	184.2	(25.3)	242.2	(24.7)	308.0	(25.4)
Construction	84.0	(13.3)	98.4	(13.5)	154.0	(15.7)	136.4	(11.2)
Manufacturing	41.4	(6.6)	44.4	(6.1)	52.8	(5.4)	62.5	(5.1)
Railroads	2.7	(0.4)	4.9	(0.7)	10.6	(1.1)	13.1	(1.1)
Business/ Consumer Services	165.6	(42.1)	187.6	(39.5)	364.8	(37.3)	468.8	(38.6)
Government/ Education	79.5	(12.6)	90.1	(12.4)	135.4	(13.8)	205.4	(16.9)
Military	0.4	(0.1)	0.4	(0.2)	0.5	(0.1)	0.6	(0.1)
Total**	631.1	(100.0)	727.7	(100.0)	979.1	(100.0)	1,214.7	(100.0)

Source: University of Wyoming 1978.

* Earnings estimates for 1978 and later years are based on employment projections. See Table R4-22 for additional discussion of employment projections.

** Totals may not add to 100.0% due to rounding.

pated that business and consumer services would remain the predominant source of earnings in the region as a whole through 1990, followed in second place by minerals extraction. However, business and consumer services would be expected to decline from 42.1% of total regional earnings in 1978 to 38.6% in 1990, while minerals extraction should increase from 22.5% to 25.4% of total earnings between 1978 and 1990. Construction should continue as the third largest source of regional earnings at least through 1985 (when it should account for 15.7% of total earnings), then decline to 11.2% as planned energy construction projects are completed. By 1990, government/education would have replaced construction as the third largest source of regional earnings, contributing 16.9% of the total. Agriculture would continue to decline in relative importance, from 2.4% of regional earnings in 1978, to 1.6% in 1990. Manufacturing is likewise projected to continue its decline in relative importance as a source of regional earnings between 1978 and 1990, from 6.6% to 5.1%.

Trends in projected earnings on the individual county level would mirror these regionwide developments to varying degrees. Minerals extraction, rather than business and consumer services, is projected to contribute the largest share of total earnings in Campbell, Converse, Crook, and Weston counties throughout most of the 1978-1990 period. Business and consumer services would be the largest source of earnings in the other four counties (Johnson, Natrona, Niobrara, and Sheridan), with shares ranging from 37.1% of total earnings (Johnson) to 50.2% (Natrona). Construction is expected to rank as the third largest source of earnings in Campbell and Johnson counties until 1985, after which it would be supplanted in third place by government/education. In the remaining six counties, government/education generally would remain third in terms of its relative contribution to total earnings throughout the period under study.

Among other sectors, manufacturing should decline as a proportion of total earnings in every county except Niobrara between 1978 and 1990. Despite a relative decline in manufacturing earnings in both cases, Natrona and Weston counties would remain the only counties which receive more than 10% of total earnings from manufacturing through 1990. Agriculture would continue its across-the-board decline as a relative source of earnings between 1978 and 1990.

Local Services

The impact of projected cumulative population growth on local services would vary widely among individual communities, depending on current service levels and capacity of facilities, as well as the rate and magnitude of expected population growth. Public services and facilities in a number of communities in the eight-county region would be overloaded. In the short term, such adverse impacts would constitute a hardship for all those involved in the growth process.

Projected service levels in individual communities are compared in the following discussion with commonly accepted service standards in order to obtain an assessment of probable impacts. While easily quantifiable, however, such yardsticks afford only a limited measure of the impact of development upon residents' lives.

Perhaps the simplest example is fire protection: while inadequate fire protection may or may not actually lead to a sudden rash of highly destructive fires, it will certainly lead to a deterioration in local fire insurance ratings and an increase in the insurance premiums of local residents and businesses. Inadequate police coverage may lead to an increase in the incidence of crime and/or traffic problems; whether or not these problems occur, apprehension and insecurity may increase among many local residents, for whom the police officer on patrol is a readily visible source of reassurance.

An inadequate water supply or treatment facility may result in insufficient water pressure (which may also impede fire fighters and lower insurance ratings), rationing of available water supplies, and unpleasant-tasting drinking water. Substandard sewage treatment facilities can cause pollution of nearby waterways and create disagreeable smells, and in extreme cases they may have to be shut down by the state or the Environmental Protection Agency.

In all cases, local residents must pay the cost of programs to ameliorate these conditions (e.g., hiring new policemen, expanding sewage treatment facilities), although financial assistance may be available from outside sources. (See discussion of local community finances.) However, to the extent that the local communities can finance the needed expansion and improvement of services, these services should begin to catch up with the population. In the long term, more and better services should be available to all.

County Services. Generally, the county sheriffs are responsible for providing police protection to rural, unincorporated areas. Major problems common to all counties include insufficient manpower and slow response times to calls, both of which are largely the result of the long distances to be covered. Most of the recent population growth has occurred in the incorporated areas; however, there has been some spillover of population, and hence increased crime, into rural areas. While the rural population would be expected to increase only slightly by 1990, this spillover effect may intensify as the urban population grows. Thus, the current manpower shortage felt by county law enforcement agencies would probably be more acutely felt in the future. (The lack of published standards for rural law enforcement agencies makes it difficult to estimate the number of additional officers and vehicles required to adequately meet present or future law enforcement needs in rural areas.)

The lack of standards or planning guidelines also makes it difficult to assess the additional manpower and equipment needed to serve current and projected rural fire protection needs. However, these needs are not expected to increase significantly, since most additional residential development would be expected to occur in incorporated areas. In addition, rural residential (as opposed to brush) fire protection in most counties (except Johnson, Natrona, and Sheridan) is provided by a joint municipal/county fire department or the municipal fire

departments themselves. The latter are evaluated below with respect to municipal fire protection requirements, which constitute their major area of responsibility.

Gillette. The Gillette Police Department would be expected to require at least 30 additional officers by 1990 (for a total force of 57), plus 10 additional patrol cars (making a total of 20 cars). Planned expansion of the municipal water supply would alleviate the city's fire-fighting deficiency, but the fire department would need an additional pumper truck of at least 1,500-gallons-per-minute (gpm) capacity by 1990. To ensure adequate manning levels, the fire department should also obtain 6 additional full-time firemen or 18 volunteers by 1990.

The city's projected water supply, augmented by water from the Madison Formation, would be inadequate to meet the needs of the projected cumulative population by 1985 and consequently, the city would need to provide an additional 4.2 million gallons per day (mgd) water supply between 1985 and 1990. In addition, Gillette would need to expand its water treatment capacity from the present level of 2.5 mgd to over 15.2 mgd. Gillette's current sewage treatment capacity (1.4 mgd) would have to be expanded to some 5.7 mgd by 1990 to meet projected needs.

Douglas. Douglas would be faced with the problem of planning services capable of meeting the temporary needs of over 15,000 people by 1985, but which would not represent excessive capacity when the population declines to under 14,000 by 1990. Meeting the police protection requirements of the peak 1985 population would require hiring an additional 15 police officers (making a total of 25), as well as purchasing 6 more police cars (making a total of 9). Since the 1990 requirement would call for a reduced total of 23 officers and 8 patrol cars, the city might meet the peak 1985 demand through a joint-powers or manpower sharing arrangement with neighboring law enforcement agencies, and simply defer routine replacement of an old patrol car beyond the 1985 population "hump"

Douglas' fire-fighting capacity would be sufficient to meet projected requirements through 1990, particularly given the availability of several county-owned fire trucks which are garaged in Douglas. However, the fire department would need up to 60 additional volunteer firemen to properly man the available equipment.

With currently planned expansion, Douglas' water supply would reach 4.0 mgd by 1980. Projected demand would outstrip capacity between 1980 and 1985, reaching a peak of 6.8 mgd by 1985. Douglas' lagoon sewage treatment facility is already inadequate by Environmental Protection Agency standards; meeting the projected 1985 peak demand would require building a new 2.5-mgd facility by 1985.

Glenrock. By 1985, the Glenrock Police Department would require 7 additional officers (making a total of 13) and 2 more patrol cars (a total of 5); no further increases should be necessary before 1990. The combined fire-fighting capacity provided by town-owned pumper trucks and county pumpers stationed in Glenrock should be adequate through 1990. However, up to 15 additional volunteer firefighters would be needed. Glenrock's current water supply and sewage treatment capacity, combined with planned increases in the water supply, should be adequate through 1990.

Moorcroft. Meeting projected law enforcement requirements would require that, in addition to the current force of 3 police officers, the Moorcroft Police Department hire 2 police officers between 1980 and 1985, plus 1 more by 1990. Adding 3 officers to the force would also require purchasing at least 1 additional patrol car between 1980 and 1985 to ensure adequate mobility. In order to provide adequate fire protection, the Moorcroft Fire Department should purchase an additional pumper truck by 1990, and recruit an additional 45 volunteer firemen.

Compared with the current 300,000-gallon-per-day (gpd) peak water supply capacity, Moorcroft would need to expand its water supply to a maximum of 670,000 gpd by 1980, one million gpd by 1985, and 1.3 million gpd by 1990. Moorcroft's sewage treatment capacity, which is adequate to meet the demands of the current population, would have to be expanded to a capacity of 475,000 gpd by 1990.

Buffalo. The Buffalo Police Department would need up to 4 additional police officers by 1990 (bringing its total strength up to 11 officers), plus 1 more patrol car (making a total of 4 vehicles). In order to provide adequate fire protection for the projected population, the Buffalo Fire Department would require an additional 1,000-gpm pumper truck, and should recruit an additional 43 volunteer firemen.

Buffalo's water supply would be sufficient to meet the needs of the projected population through 1990. However, Buffalo would have to increase its sewage treatment capacity, which is inadequate to serve the needs of the present population, to at least 875,000 gpd by 1990.

Casper, To maintain acceptable levels of police protection, Casper would have to hire at least 11 more police officers by 1990, and purchase 3 more patrol cars (for a total of 84 officers and 22 patrol cars). While the Casper Fire Department would not require any additional fire trucks between 1978 and 1990, up to 25 additional fireman should be hired to maintain current service levels.

Casper's current peak water supply is approximately 35 mgd, which should be adequate to meet the demands of the projected population through 1990. The city's 6.5-mgd sewage treatment plant is currently operating at near maximum capacity, and would have to be expanded to a 9.7-mgd capacity by 1990 to meet the demands of the projected population.

Lusk. Lusk's current police manpower and equipment levels would be sufficient to meet projected needs through 1990. However, the fire department should acquire an additional 750-gpm to 1,000-gpm pumper, as well as recruit an additional 20 volunteer firemen. Lusk's water supply should be adequate through 1990. However, the city would need to replace its current sewage treatment facility with a 22-acre lagoon system to meet the projected demand through 1990.

Sheridan. To meet demands of the projected population, Sheridan should increase its police force by at least 11 officers by 1990 (a total of 39 officers) and acquire 4

additional patrol cars. The manning and equipment of the Sheridan Fire Department should be adequate through 1990.

Sheridan's current water supply capacity of 10 mgd should be adequate to meet the needs of the population until 1990, when the projected demand would reach 10.2 mgd. The maximum design capacity of the city's sewage treatment plant (5.0 mgd) should be adequate through 1990, provided the efficiency of the present system is improved.

Newcastle. The Newcastle Police Department would require at least 2 additional officers by 1990 (a total of 11), plus 1 additional patrol car (a total of 4). An additional 500-gpm pumper truck, plus up to 60 additional volunteer firefighters, would be necessary to meet projected fire protection requirements through 1990.

The ability of Newcastle's water supply to meet future demands would depend on the yield of a fourth well to be completed in mid-1978, but the combined output of the four city wells probably would not exceed 4.4 mgd, or 300,000 gpd less than the 1990 projected requirement. Newcastle's present lagoon would have to be supplanted by facilities capable of treating approximately 900,000 gpd by 1990.

Housing

Table R4-24 shows projected cumulative growth of housing demand in local housing markets, compared with historical growth rates in the housing stock. The projected annual growth in demand for single-family housing varies from a low of 0.3% in Buffalo to a high of 8.9% in Moorcroft. In Gillette, the demand for single-family housing would be expected to grow at a rate of 6.4% annually between 1977 and 1990. The demand for single-family housing in Douglas and Glenrock is projected to grow at average annual rates of 3.6% and 4.6% respectively. Based on comparisons with historical rates of growth in the local stock of single-family housing, the local housing market should be able to meet the additional population demand for single-family homes through 1990, since the latter is generally expected to grow at a slower rate than the historical growth in the single-family housing supply. This conclusion is strengthened by the fact that the local housing market by 1978 had largely overcome two obstacles (i.e., uncertainties regarding the extent of future coal development and the absence of a well-developed local housing construction industry) which inhibited single-family home construction in the early 1970s (Denver Research Institute 1977).

However, Table R4-24 measures only effective demand, i.e., households desiring *and* able to afford the high cost of single-family housing. Many other households (mainly those with single wage earners employed in occupations other than the relatively high-paying mining and construction sectors) would prefer single-family homes, but would have to settle for lower-cost multi-unit or mobile housing. In communities like Gillette, Douglas, Glenrock, Moorcroft, and Newcastle, where a large percentage of the new arrivals would be employed in the high-paying mining and construction sectors, the majority (i.e., 60%-70%) of households desiring single-family housing could afford it. In other communities, where a smaller percentage of the new residents would be mining or construction employees, and where there would be fewer multiple wage-earner households, as many as 50%-80% of the households desiring single-family housing by 1990 would be unable to afford it. The resultant disappointment and frustration among would-be homeowners is a significant adverse impact of rapid population growth in these communities.

Alongside those households forced to accept multi-unit or mobile housing by high single-family home costs are those households for whom multi-unit or mobile homes would be the preferred housing mode. (This group includes particularly transient construction workers.) A great increase in demand between 1977 and 1990 for multi-unit and mobile housing accommodations would be expected in certain communities, particularly Gillette, Douglas, Casper, and Sheridan. However, sufficient growth in the multi-unit and mobile housing market to meet projected demand is not assured. Potential obstacles include the relatively high business risks associated with either multi-unit housing projects or mobile home parks in the region, and the local shortage of commercial credit. These factors would discourage some developers and make it difficult for others to obtain needed bank credit. Some local officials, bankers, and residents are also unsympathetic to the need for additional mobile home parks, rendering it difficult to obtain land for additional mobile home lots (Denver Research Institute 1977). A solution to these interrelated problems—the high cost of single-family housing, and the limited range of housing alternatives available—would be a precondition if the region's housing needs are to be met adequately. Several policies are already in effect to alleviate these housing problems. Some coal companies, for example, have played active roles in developing subdivisions (e.g., the community of Wright in Campbell County), and in some cases they have even subsidized a portion of the cost of this housing. The state of Wyoming, through the Wyoming Community Development Authority, also has a program to make mortgage funds available at a reduced rate. These, and similar programs, would have the potential to ease the critical local housing situation.

Education

The following section discusses projected school district enrollments for the eight-county region (see Table R4-25). The most significant impacts would be experienced in the Gillette, Douglas, Casper, and Sheridan school districts.

In the Gillette School District, current building capacity plus planned expansions would bring total district capacity to 6,921 pupils by 1982, which is sufficient to meet projected enrollment increases through 1990. The district would also need to hire an additional 152 teachers by 1990 in order to maintain current pupil/teacher ratios.

In Douglas, current plus planned building capacity would only be adequate through 1982, after which capacity must be expanded by an additional 1,015 spaces to

TABLE R4-24

PROJECTED CUMULATIVE HOUSING DEMAND
1978-1990

Community/ Housing Type	1977 Housing Stock	Average Annual Growth Rate of Housing Stock, 1970-77*	Demand for Additional Housing Units Beyond Current Stock: 1978-1990 Total No. of Units	Demand for Additional Housing Units Beyond Current Stock: Average Annual Growth of Housing Stock Required, 1978-90*
Gillette**				
Single Family	1,623	5.2%	2,007	6.4%
Multi-Unit	680	6.3	513	4.4
Mobile	1,542	13.3	1,573	5.6
Total all types	3,845	8.1	4,093	5.7
Douglas				
Single Family	1,232	6.5	728	3.6
Multi-Unit	207	0.7	353	8.0
Mobile	349	24.8	1,228	12.3
Total all types	1,788	8.2	2,309	6.6
Glenrock				
Single Family	439	NA	318	4.3
Multi-Unit	63	NA	162	10.3
Mobile	159	NA	569	12.4
Total all types	661	3.7	1,049	7.6
Moorcroft				
Single Family	147	NA	296	8.9
Multi-Unit	0	NA	65	0
Mobile	150	NA	233	7.5
Total all types	297	NA	594	8.8

TABLE R4-24
(cont'd)

PROJECTED CUMULATIVE HOUSING DEMAND
1978-1990

Community/ Housing Type	1977 Housing Stock	Average Annual Growth Rate of Housing Stock, 1970-77*	Demand for Additional Housing Units Beyond Current Stock: 1978-1990 Total No. of Units	Demand for Additional Housing Units Beyond Current Stock: Average Annual Growth of Housing Stock Required, 1978-90*
Buffalo				
Single Family	1,398	4.8%	55	0.3%
Multi-Unit	93	-12.0	44	3.0
Mobile	130	11.4	164	6.5
Total all types	1,621	3.3	263	1.2
Casper				
Single Family	12,034	2.3	718	0.4
Multi-Unit	3,580	3.0	376	0.8
Mobile	655	18.1	1,225	8.4
Total all types	16,269	2.8	2,319	1.0
Lusk				
Single Family	NA	NA	17	NA
Multi-Unit	NA	NA	22	NA
Mobile	NA	NA	93	NA
Total all types	720	0.2	132	1.3
Sheridan				
Single Family	3,993	2.1	600	1.1
Multi-Unit	477	-3.0	421	5.0
Mobile	780	45.7	1,563	8.8
Total all types	5,250	2.4	2,687	3.2
Newcastle				
Single Family	950	0.4	369	2.6
Multi-Unit	246	6.1	81	2.2
Mobile	172	9.9	242	7.0
Total all types	1,368	1.6	592	2.8

TABLE R4-24
(cont'd)

PROJECTED CUMULATIVE HOUSING DEMAND
1978-1990

Source for 1977 housing stock: see Table R2-40.

Note: Two major factors were taken into account in compiling Table R4-24: workers' personal preferences for different types of housing (Table R2-42) and their ability to pay for the type of housing desired (Table R2-44). First, housing preferences of the incremental population were estimated by occupational group, using the percentages in Table R2-42. The only exception is, that after 5 years' local residence, newcomers' housing preferences are assumed to be the same as those of long-term residents.

Effective demand for different types of housing (consisting of households desiring and able to afford a particular type of housing) was then calculated for each occupational group using the bankers' rule of thumb that a family's monthly housing expenditures should not exceed 25% to 33% of its monthly income. According to Table R2-44, in the future, only households headed by mining and construction workers will be able to afford single-family housing, or households with multiple wage earners. Projections of the number of mining and construction workers were obtained from employment projections in Table R4-22, and the number of households with multiple wage earners was estimated based on data in the _1970 Census of Population_ for Wyoming (U.S. Department of Commerce 1970).

Households desiring, but unable to afford, single-family housing were allocated to mobile housing units.

* Average rate of change, compounded annually.

** 1977 figures for Gillette do not include housing located outside city limits, since comparable data for 1970 were unobtainable. Consequently, average growth rate in housing stock 1970-77 is probably understated.

NA = not available

TABLE R4-25

PROJECTED CUMULATIVE SCHOOL DISTRICT ENROLLMENTS
1980-1990

	1980				1985				1990			
	Elem.	J. H.	H. S.	Total	Elem.	J. H.	H. S.	Total	Elem.	J. H.	H. S.	Total
Campbell												
Gillette	2,822	1,129	847	4,798	3,426	1,370	1,028	5,824	3,948	1,579	1,184	6,711
Converse												
Douglas	1,312	469	375	2,156	2,248	803	642	3,693	2,055	734	587	3,376
Glenrock	481	222	185	888	664	306	255	1,225	673	311	254	1,243
Crook												
Sundance	713	359	335	1,408	829	417	389	1,637	897	451	421	1,771
Johnson												
Buffalo	763	334	324	1,420	802	351	340	1,493	847	371	360	1,578
Natrona												
Casper	7,271	3,298	3,523	14,092	8,039	3,647	3,895	15,581	8,932	4,051	4,327	17,310
Niobrara												
Lusk	304	155	161	621	312	160	166	639	321	164	171	656
Sheridan												
Ranchester	361	188	189	738	362	189	189	740	361	191	189	742
Sheridan	2,009	961	872	3,842	2,507	1,199	1,080	4,794	3,102	1,483	1,385	5,930
Clearmont	89	21	34	144	89	22	34	145	89	22	35	146
Weston												
Newcastle	713	324	353	1,390	792	360	391	1,543	859	390	426	1,675
Upton	245	109	104	458	272	121	116	509	291	129	124	544

Source: Based on University of Wyoming (1978) WRRI model projections.

meet the 1985 peak demand. Since long-term projections show cumulative enrollment declining to 3,376 by 1990, the school district might elect to meet at least part of the additional demand through the use of portable or temporary classrooms, utilization of other community facilities (e.g., library meeting rooms, church halls), subdividing existing classrooms with room dividers, or busing children. The district would also require approximately 100 additional teachers by 1985, of whom only 80 would need to be long-term appointments in view of the projected enrollment decline after 1985.

Despite an active building program which would bring Casper's total district capacity to 15,011 pupils by 1982, projected continued enrollment growth would require that Casper provide for an additional 2,300 pupils by 1990. The requirements would probably include at least two new elementary schools, a new junior high school, and additions to one or both of the existing high schools. The district would also require an additional 160 teachers by 1990.

Sheridan's current plus planned facilities should be augmented by 1,741 spaces by 1990. Needed facilities would probably include three more elementary schools plus a new junior high or high school. Sheridan would also need at least 114 new teachers by 1990.

The remaining school districts should be able to meet projected cumulative enrollment increases without major capital investments beyond those currently planned, through building additions and the use of modular or temporary classrooms. While most would have to hire some additional teachers, the required increases would be relatively small.

Health Care

Chapter 2 discussed the shortage of health care personnel in most local communities. Unless these communities have significantly greater success in attracting and holding new medical specialists, this shortage would be aggravated by projected population increases.

Table R4-26 projects the number of additional physicians, registered nurses, and dentists required to provide recommended levels of health care to the local population through 1990. According to the table, the region would need an additional 78 physicians and 69 dentists by 1990. On the individual county level, Johnson, Natrona, Niobrara, and Sheridan counties have sufficient registered nurses (but not doctors or, with the exception of Sheridan, dentists) to meet their requirements through 1990. Campbell, Converse, Crook, and Weston counties would face continuing deficiencies in all three major health care personnel categories unless they can attract additional doctors, dentists, and nurses.

Hospital bed needs in the region are more difficult to project on a county-by-county basis. The role of the 297-bed Natrona County hospital as a regionwide health center and the fact that many area residents cross county lines to obtain hospital service make it necessary to address hospital needs on a regionwide basis. Present hospital facilities as well as those either under construction or planned should be sufficient to meet the projected demands of the population through 1980. By 1985, however, the region would need 119 additional hospital beds, increasing to 186 beds by 1990. These needs could be met through new hospital construction or, if possible, by increasing the presently low average utilization rate of existing bed facilities (see Chapter 2).

Retail Trade

If it is assumed that future per capita retail expenditures (measured in constant 1975 dollars) in the eight-county region would continue to grow at the historical rate of 0.7% annually through 1990 (see Chapter 2), then total 1990 retail sales in the region are projected at approximately $760 million (1975 dollars), a 74% increase since 1975.

Natrona County (i.e., Casper) would be expected to continue as the region's principal trade center through 1990. Natrona County captured more than half of all new retail trade in the eight-county region between 1972 and 1977. However, the growth of other, secondary trade centers (particularly in neighboring Converse County, which is expected to undergo rapid growth in the next decade), should reduce Natrona County's relative attractiveness as a trade center in future years. Taking this into account, total 1990 retail sales in Natrona County are estimated at $327 million (1975 dollars), or approximately 43% of total regional sales.

In recent years, Campbell County (Gillette) and Sheridan County (Sheridan) have emerged as secondary trade centers in their own right. Between 1972 and 1977, both enjoyed shares in regional sales approximately proportional to their respective shares in regional population. On a similar basis, 1990 retail sales in Campbell County are estimated at $137 million (1975 dollars), compared with $114 million (1975 dollars) in Sheridan.

Population projections suggest that Converse County by the mid-1980s may also attain the status of a secondary trade center, capable of providing for the greater part of its residents' needs and drawing shoppers from neighboring counties. As such, Converse County may expect annual retail sales up to $68 million (1975 dollars) by 1990, concentrated in the towns of Douglas and, to a lesser extent, Glenrock.

Local Finances

Projected population increases, together with coal and other related development, would increase the revenues at the disposal of local governments, while simultaneously increasing their operating and capital outlay requirements. It is possible for local governments to run with short-term deficits, but in the longer term they must balance revenues and expenditures. If anticipated revenues are insufficient to cover expected costs, either additional sources of funds must be found, or planned expenditures must be scaled down.

Principally due to the large property tax base at their disposal, local county governments and school districts should be able to meet the service and educational re-

TABLE R4-26

PROJECTED HEALTH CARE PERSONNEL REQUIREMENTS

	1977 Physicians	Physicians Recommended Levels*			1977 Registered Nurses	Registered Nurses Recommended Level**			1977 Dentists	Dentists Recommended Level***		
		1980	1985	1990		1980	1985	1990		1980	1985	1990
Campbell	9	28	34	39	53	99	120	139	4	18	21	25
Converse	6	13	21	20	29	46	74	70	2	8	13	12
Crook	2	5	6	7	11	19	22	24	1	3	4	4
Johnson	4	7	7	8	30	24	25	27	2	4	5	5
Natrona	80	75	83	92	383	263	291	323	34	47	52	58
Niobrara	2	3	3	3	12	11	11	11	1	2	2	2
Sheridan	26	24	27	32	154	83	96	111	16	15	17	20
Weston	3	7	8	9	26	26	29	31	2	5	5	6
Region	132	163	191	210	698	571	669	736	62	102	119	131

Source: Wyoming Department of Health and Social Services 1977; personal communication, Larry Bertilson, State Health Planning Manager 1978.

* Based on recommended standard of 1,000 persons per physician.

** Based on recommended standard of 285 persons per registered nurse.

*** Based on recommended standard of 1,600 persons per dentist.

quirements of the projected population through 1990. For municipal governments, the outlook would be mixed. Most municipalities are expected to be able to meet their projected long-term operating requirements without seeking major additional outside funding or cutting back on expenditures.

Those municipalities which would face potential operating deficits without the injection of new local or outside funds or spending cutbacks include Douglas, Glenrock, and Moorcroft. Douglas would face a maximum operating shortfall of over $1 million by 1985, while Glenrock and Moorcroft would face smaller potential annual operating shortfalls of $50,000 and $25,000 respectively by 1990. The opportunities for Douglas and Glenrock to raise additional local revenues by levying additional taxes would be rather limited since Converse County already levies the optional 4% sales tax and neither city can increase its general purpose property tax levies much more due to legal limitations. Addition of the 4% optional sales tax in Crook County would help redress Moorcroft's prospective operating shortfall. Otherwise, these communities would have to either turn to the state or federal governments for financial assistance or cut back on service levels in order to avoid chronic operating deficits.

Municipal governments also vary in their ability to meet the capital costs of additional facilities requirements. Serious problems would occur in Gillette, which, while able to meet projected future operating costs, would face at least a $11.9 million capital requirement by the 1990. Douglas would face capital requirements of up to $5 million in excess of its legal bonding capacity, depending on the type of sewage treatment facility built. Moorcroft would have to raise some $500,000 for needed water and sewer system improvements, while needed improvements in Buffalo's and Newcastle's water and sewage systems might cost each town up to $3 million, depending on the type of sewage treatment facility provided. Casper would require $5.5 million for needed expansion of its water supply and sewage facilities.

Expenditures of this magnitude would be beyond local financing capabilities through either current revenues or bonded debt. Possible outside sources of financial assistance include state coal severence tax funds, the U.S. Farmer's Home Administration, or Environmental Protection Agency, as well as the private coal companies.

CHAPTER 5

UNAVOIDABLE ADVERSE IMPACTS OF CUMULATIVE REGIONAL DEVELOPMENT

The following impacts would remain after application of the planning and environmental controls discussed in Chapter 3. Whether certain impacts (such as those related to visual resources or socioeconomics) are adverse is a matter of personal preference. To the long-time resident who cherishes a traditional life-style, change probably would be adverse. To new residents, and those interested in economic and urban development, signs of growth would likely be welcome.

By 1990, a total population increase of 21,614 in Campbell and Converse counties is expected over the 1978 level of 37,780. The following impacts would result; they would be felt most strongly in the municipalities of northeastern Wyoming: (a) annual operating budget shortfalls of $1 million in Douglas by 1985 and $50,000 in Glenrock and $25,000 in Moorcroft by 1990; (b) capital budget shortfalls of $7 million in Gillette by the early 1980s, $5 million in Douglas by 1985, and lesser amounts in smaller communities; (c) continued high housing costs and shortages of rental units would force many households to accept inadequate housing; (d) temporary shortfalls in health services, classroom space, numbers of teachers, police and fire protection, and water and sewer services— provision of additional facilities and manpower would depend on solution of budget problems; (e) unavoidable sociological impacts relating to family problems, child abuse, and mental health—these impacts would be felt particularly in Gillette, Douglas, and Moorcroft; and (f) loss of the traditional regional agricultural life-style.

Coal train traffic would be increased from 60 to 300 unit trains per week (one way) along the main regional rail routes by 1990. Coal traffic between Donkey Creek and Alliance, Nebraska averaged about 60 unit trains per week (one way) in 1978. Impacts of rail traffic, such as noise and delays at crossings, would be quadrupled by 1990. Predicted 1990 coal train traffic is approximately 62% more than present track capacity. Completion of the rail line from Donkey Creek to Orin Junction in mid-1980 would approximately double track capacity. However, by 1990 coal train traffic would amount to approximately 82% of track capacity; total (coal plus other freight) train traffic would approximately equal track capacity.

The number of registered motor vehicles in Campbell and Converse counties would increase from about 35,700 in 1978 to about 56,200 in 1990. Increased road use would mean increased maintenance costs and vehicle accident rates.

When aquifers are disrupted by mining, lowering of water levels would occur in the overburden, coal, and some deep aquifers in the vicinity of mines and would possibly dry up some springs and seeps while reducing streamflow in areas around mines. The extent of the cones of depression around the mined areas would depend on aquifer properties and time. Local areas in southeast Campbell County would change from groundwater recharge to discharge areas during the time of mining.

Water in aquifers which develop after reclamation would be of poorer quality than in the premining aquifers. "Water in spoils was found to be significantly more highly mineralized than natural groundwater in terms of total dissolved solids, calcium, magnesium, and sulfate,"according to Rahn (1976, p. 54). Such water may exceed levels recommended for drinking water and irrigation.

Municipal water use would increase from 7,030 acre-feet annually in 1978 to 11,100 acre-feet annually in 1990. Additional water use is anticipated for industrial uses such as secondary and tertiary oil recovery, uranium milling, and coal conversion, as well as for agricultural needs for irrigation and domestic water. Total water use in the region by 1990 is expected to reach 78,000 acre-feet annually, or an increase of 26,030 acre-feet annually over 1978 levels. Increased water use would affect mostly population centers. Short-term water shortages could occur until the need for the water is eliminated or alternate sources are found. Such shortages would be most likely in Douglas, Gillette, Moorcroft, and Newcastle and would range (without expansion of present treatment plants) from 300,000 gallons per day to 7.5 million gallons per day.

Water pollution, a combination of hundreds of possible contaminants, which may result from increased population and industry may have an indeterminate adverse impact on public health. Some of the factors which would affect the scale of the impact are the lag time between municipal growth and establishment of corrective municipal services, the proportion of the population increase which settles outside municipalities and along stream channels, and the tenacity with which environmental laws and regulations are enforced.

Erosion and consequently sedimentation within mine areas would be greatly increased. The potential sedimentation rate by 1990 is estimated at 340 acre-feet per year for the region, whereas the rate in 1978 is 160 acre-feet per year. Leachate from spoil piles and replaced over-

burden would reduce surface water quality (see Table R4-5). Only a small portion of these impacts would be felt beyond mine areas, unless very heavy storms (100-year floods) cause breaching of the catchments and settling ponds.

There would be unavoidable localized increases in sedimentation and loss of aquatic habitat resulting from the proposed mining and associated activities. Disruption of the shallow groundwater system would destroy some point-watering sources and lush forage (along streams and including possible alluvial valley floors) during mining. The loss of watering sources would discourage stock and wildlife grazing in the affected areas. Loss of aquatic habitat and point-watering sources is expected on 330 acres of pond (including wells, playas, and springs) and 49 miles of stream by 1990. Losses by 1978 amount to 110 acres of pond and 16 miles of stream.

The area of the region where the ambient total suspended particulate (TSP) concentrations would be most affected by coal mining is a strip approximately 22 miles long and 2½ miles wide in southeast Campbell County (Map 1, Appendix A). From 1980 to 1990, annual TSP concentrations are predicted to rise from 31 $\mu g/m^3$ to 40 $\mu g/m^3$, well below the Wyoming standard of 60 $\mu g/m^3$.

A slight increase of TSP concentration is expected to be caused by population growth in Gillette and emissions from Rawhide and Eagle Butte mines between 1980 and 1990. For most of this area, the TSP concentrations are expected to remain below the Wyoming ambient air quality standards. But, it is possible that the Wyoming 24-hour standard of 150 $\mu g/m^3$ may be exceeded in downtown Gillette. However, the national primary standard of 260 $\mu g/m^3$ would probably not be reached. The annual TSP concentrations around Moorcroft are predicted to increase 5 $\mu g/m^3$ between 1980 and 1990. The resultant TSP concentrations in 1990 of 30 $\mu g/m^3$ would be one-half of the Wyoming standard.

The average annual horizontal visibility away from mines and towns in the region is expected to remain near the regional baseline of 54 miles. In Gillette, the annual visibility is expected to decrease from 28 miles in 1980 to 22 miles in 1990.

The future air quality is compared to existing air quality using 1980 as the base year because of lack of air quality and emissions data for 1978.

Regionally, by 1990, all soil productivity would be lost an average of 8 to 10 years on 22,794 acres due to coal mining disturbance, or on a total of 59,403 acres for all regional development activities. These acreages represent .5% and 1% of the regional acreage respectively. Soil productivity on a total of 3,242 acres would be lost permanently due to housing developments. The disturbance of topsoil would lower to some degree the natural soil productivity by compaction, mixing natural soils, and through soil erosion.

Soil productivity on reclaimed areas (25,966 acres by 1990) would vary depending on soils types and reclamation practices on each project. Productivities may be reduced due to alteration of topsoil thickness, quality, salinity, alkalinity, acidity, or clay content. If these factors retard reclamation, erosion may increase. There would also be a reduction in productivity of stockpiled topsoil due to loss of seeds, roots, microorganisms, organic matter, and nutrients.

If a 25-, 50-, or 100-year flood occurred when mined areas were in the process of being reclaimed, an accelerated rate of erosion would occur, resulting in large amounts of soil loss and lengthening the time required for revegetation.

Wind and water erosion or contamination by spillage of toxic materials (such as oil or gasoline) would cause the loss of 5% to 10% of available topsoil material.

After disturbance and reclamation, vegetative species diversity would be lost. Vegetation on reclaimed land (25,966 acres by 1990) is expected to be dominated by grasses. Lack of diversity reduces stability of the vegetative community and the variety of wildlife it supports.

An indeterminate amount of vegetation would be impacted by dust fallout from development activity.

An estimated 3,981 animal unit months (AUMs—based on domestic livestock use where one cow equals one animal unit month) (or 0.2% of those available in the region) would be lost annually due to total regional development activities by 1990. A cumulative permanent loss of 9,726 AUMs (0.5%) would be sustained by this time period on 3,242 acres due to increased population needs (new house construction). Additionally, 2,060 acres of cropland (2.0% of the regional total) would be lost by 1990 from all development activities.

Expansion of residential areas and mine development would decrease the land base available for recreation, decrease wildlife habitat (and hence hunting opportunity), and interfere with sightseers' enjoyment of the natural landscape. Acreage disturbed and unreclaimed by 1990 would total 36,679, or more than twice that disturbed and unreclaimed in 1978.

Present recreation areas would have to meet the demands of increased population. Increased maintenance and repair costs would result. Resource damage may occur.

Conflicts between private landowners and recreationists would increase, probably resulting in further restriction of public access to and across private land.

The quality of the traditional "primitive"recreation experience would decline in the region due to increased population.

Wildlife habitat would be temporarily lost on 22,794 acres (.5% of the region) of coal mine disturbance, or on a total of 59,403 acres (1% of the region) due to total regional development activities. Approximately 3,242 acres would be indirectly and permanently affected by 1990 due to residential and other urban structures.

By 1990, 1% of the regional pronghorn population, 1% of the regional mule deer population, and unknown percentages of regional small game and game bird populations would be lost due to direct habitat destruction. Projected losses due to poaching and road kills could increase these losses to 5.8% of the pronghorn population, and 23.7% of the mule deer population by 1990.

Increased demand for big game hunting, along with reduced numbers of animals to hunt, would reduce the quality of sport hunting in the region. The increased

losses to poaching would make less game available for legal harvest. This would increase the competition for the remaining big game tags. The increased numbers of resident hunters would cause fewer nonresident permits to be sold in the region. This would cause a loss of income to the state wildlife agency, if hunting license fees are not adjusted.

Indirect loss of habitat carrying capacity would occur, most notably in a strip of land approximately 65 miles long and 2 miles wide (Map 1, Appendix A), where numerous new roads, fences, mines, railroad spurs, and powerlines would be built. By 1990, 1.7% of regional mule deer yearlong range, 2.7% of pronghorn yearlong range, and 2.6% of pronghorn winter-yearlong range would be directly or indirectly affected by various mines throughout the region. These impacts would range from direct habitat destruction to noise, increased human activity, harrassment, and fencing of unmined areas.

The loss of habitat diversity and special topographic features, such as cliffs, would be an unavoidable loss under current reclamation practices.

Expanded urban areas, service facilities, and new transportation and utility networks to serve the increased population and industrialization would be permanent intrusions in the characteristic landscape.

All mine pits, stripped areas, industrial structures, machinery, buildings, and support structures (power lines, railroad spurs, and access roads) would be visual intrusions in the characteristic landscape until abandonment and revegetation is complete.

Almost 2 billion tons of coal would be mined in the region by 1990. In addition, 5% to 10% of the coal would be lost because present mining methods and economics do not permit its complete recovery from overburden or partings.

All cultural resources within the region would be affected by increased vandalism and pothunting as the population increases. Surface indications of important buried sites might be lost. Significant information might be lost to the records of the region's prehistory.

Natural topography on 22,794 acres (.5% of the region) would be altered by coal mine pits and cuts and fills, and then reclaimed to unnaturally smooth contours. Replaced overburden would be unstable, tending to settle or shift over time. Even though general topography of the area can be restored, cliffs and abrupt breaks, presently a part of the topographic scene, cannot be restored. Additional topography on approximately 39,000 acres (.8% of the region) would be altered by coal conversion facilities, rail and power systems, other mineral development, and population growth.

The Buckskin Mine (site-specific action) is included as a part of the cumulative regional development impacts discussed above and represents 4.6% of the 22,794 coal mine acres analyzed.

CHAPTER 6

RELATIONSHIP BETWEEN SHORT-TERM AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

The region has an established coal industry (fifteen mines are already operating or pending approval), and is facing continued development of other minerals such as oil, gas, and uranium. Projected coal development (including the site-specific project under consideration) in response to national energy needs would increase production to 173.3 million tons annually from fifteen mines by 1990. Production could level off or continue to increase beyond the 1990 projection, depending on market demands.

By 1990, about 2 billion tons of coal would be mined, or 9.2% of the estimated strippable reserves of the region. This low-sulfur coal would be made available to the region and other parts of the country; it would be consumed in the production of electricity or synthetic natural gas. About 150 million tons of coal would be lost by 1990, because current mining technology does not permit its economic separation from overburden and partings.

The 1978 population of Campbell and Converse counties is estimated at 37,780. By 1990, this figure would reach 59,394.

In the short term, the increased employment due to coal mining and coal transportation would create labor shortages in the nonmine sectors of the economy. In the long term, as more people move into the region, a labor force of sufficient size to meet the needs of all employers would be available. In addition, this increased employment would tend to hold the unemployment rate at its current low level.

Increased wage earnings and higher per capita income would in turn increase retail and wholesale trade over the life of each mine. This would be a short-term gain, while the loss of buying power of people on fixed incomes would be long term.

In the short term, housing shortages would continue and crowded conditions would be exacerbated. However, over the long term, the housing stock would eventually increase and match the demand.

Crowding of classrooms and increased student/teacher ratios would occur in the short term. In the long term, new facilities would be built, more teachers would be hired, and the tax base would increase to pay for these needs.

Health care in this region may never be considered up to standard, but over the long term the population/health care specialist ratio would at least remain at the current level.

Although there would be a short-term overtaxing of some local services (water, sewer, police and fire protection, solid waste disposal, transportation), this situation would be corrected as new sewer and water systems are built, more police and fire personnel are hired, and new solid waste disposal sites are developed, and highways and airports are improved.

Since mined areas can be reclaimed and restored to other uses, mining represents a short-term commitment of land use. Land occupied by expanded urban areas or new transportation facilities would be permanently committed to those developments.

Short-term disturbance of the soil resource would disrupt the productivity levels, destroy existing soil profiles, and increase soil erosional losses on 59,403 acres (1% of the region) by 1990. Soil productivity levels would be restored in the long term to varying degrees, and in some cases could equal 100% of the premining levels with successful reclamation.

Regional development would result in short-term losses of vegetation on 59,403 acres (1% of the region) by 1990. Vegetative productivity would be regained within 10 years after reclamation begins. The diversity typical of native vegetation would take 30 or more years to redevelop on reclaimed areas (University of Wyoming, Black Thunder Project Research Team 1976). This would, in turn, affect wildlife diversity.

The use of 3,242 acres for housing and support services would be a long-term conversion of land use. Productivity in relation to soils, vegetation, livestock grazing, and wildlife habitat would be lost, but productivity as measured in benefits to people would be enhanced.

A total of 59,403 acres of wildlife habitat (1% of the region) would be lost for the short term by 1990. One percent of the regional pronghorn and mule deer populations would be lost due to direct habitat destruction. A total of 1.7% of all mule deer yearlong habitat, 2.6% of pronghorn yearlong habitat, and 2.7% of pronghorn winter concentration-yearlong habitat would be destroyed or affected by new roads, fences, increased human activity and noise. A total of 1.4% of all big sagebrush habitat and 3.6% of all silver sagebrush habitat in the region would be destroyed by 1990. Under current reclamation practices, these areas would be reclaimed to grasslands. Repopulation of reclaimed areas by small mammals and some nongame birds should occur after a healthy stand of vegetation is established. The rate of repopulation, and postdisturbance densities are unknown.

SHORT TERM VS. LONG TERM

The loss of an average of 3,981 animal unit months (AUMs) of grazing annually, the effects of dispersed recreational activities on livestock management, and the effects of haul road dust and fugitive coal dust on vegetation would be short-term losses.

Regional mineral development would temporarily consume a small part of the prevention of significant deterioration of air quality (PSD) increments. However, violations of Wyoming air quality standards are not expected except at or within mine boundaries.

Increased traffic and urbanization due to population growth would cause a long-term rise in pollutant concentrations in and near towns.

Disturbance of cultural resource sites, even with salvage, would represent a long-term commitment.

The Buckskin Mine is included in the above discussion of cumulative regional development.

CHAPTER 7

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES BY CUMULATIVE REGIONAL DEVELOPMENT

In order to place these commitments in proper perspective, the reader is referred to Chapter 5 where a summary of these cumulative regional impacts (through 1990) may be found.

Approximately 2 billion tons of coal would be extracted and consumed as a result of regional coal mining operations through 1990, with an additional 100 to 200 million tons left as unrecoverable by present mining methods.

A large quantity of sand, gravel, and scoria estimated to be over 2 million cubic yards, would be committed to construction of mine facilities, and roads and houses to accommodate the increased population.

Energy, in the form of petroleum products and electricity, would be consumed in order to extract, convert, or ship the coal, for other development activities, and by the increased population.

The traditional life-style of towns and counties in the region would undergo additional integration with newcomers' life-styles. By 1990, newcomers' life-styles would likely predominate.

Loss of human life due to rail, highway, or mine accidents would be irreversible and irretrievable. The estimated potential fatality rate for coal strip mining is 1 per 14.3 million tons of coal produced, or 12 lives per year for the 174 million tons of coal mined annually by 1990.

Destruction of the physical structure of the premining aquifers would be irreversible. Water in aquifers which develop after reclamation would be of poorer quality than in the premining aquifers due to high levels of dissolved solids and ions. The water may be unsuitable for drinking water or agricultural uses.

Some premining point-watering sources at 330 acres of pond or wells and along 49 miles of creek would be destroyed; the resulting loss in water source density and dispersion could cause an unquantifiable reduction in wildlife habitat and grazing range.

Existing soil associations, vegetative forage production of 9,700 animal unit months (AUMs) on a cumulative basis by 1990, total wildlife habitat and carrying capacity, and recreation land base would be permanently lost on 3,242 acres due to expansion of urban areas.

The aquatic habitat presently existing on the mine sites (330 acres of pond or wells and 49 miles of stream) would never be replaced, but a different community would naturally reestablish itself.

The quality of the "primitive"recreation experience would decline, and damage occurring to natural values throughout the region because of overuse or inadequate recreation management could be irreversible.

Wildlife presently occupying mine sites and other areas of disturbance would be displaced and lost. One percent of the regional pronghorn and mule deer populations would be lost as a direct result of habitat destruction. The loss of all wildlife populations on disturbed areas would be an irreversible commitment of wildlife resources. The loss of cliffs, rocky outcroppings, and other special habitat features would be irreversible.

Houses, service facilities, utilities, and roads built to accommodate the increased population would irreversibly commit visual resource Class II, III, and IV areas to Class V.

Land surfaces consisting of cliffs and abrupt breaks could not be restored to their original conformation after disturbance.

Cultural resources in areas of surface disturbance would be committed to either destruction or salvage; in either case, additional information would not be available to future researchers. However, present researchers would have the benefit of information gained from material exposed through mining operations.

The removal by amateurs of collectible minerals, fossils, or cultural resources would be an irreversible loss.

The Buckskin Mine is included in the cumulative regional development discussed in this chapter.

CHAPTER 8

ALTERNATIVES

INTRODUCTION

This regional analysis evaluates the cumulative impacts of coal development in the Eastern Powder River Basin. The production level evaluated as the probable level is dependent in part on the federal approval of the Buckskin mining and reclamation plan (M&RP) on an existing federal lease. However, the Secretary of the Interior is not proposing a particular production level for coal in the Eastern Powder River Basin. Instead, he is considering actions within his authority that will allow federal coal to be available where needed and under environmentally acceptable conditions.

In this analysis, decisions regarding M&RPs and coal-related actions are assessed on a regional basis. Accompanying and future related site-specific statements will evaluate alternatives specific to the individual coal development proposals. Thus, alternatives for the M&RPs and coal-related actions are evaluated on an aggregate basis in this statement, providing a means of responding to regional environmental problems or social and economic concerns.

The Secretary's action in regard to the M&RP under consideration in this site-specific analysis may be approval, approval of the M&RP after specific requirements have been met, or rejection on various environmental or other grounds. He may also defer decision pending submittal of additional data, completion of required studies, or for other specific reasons. If there are serious environmental concerns as to the coal development, the Secretary may exercise his exchange authority as to the federal coal rights or he may seek Congressional action cancelling the federal leases involved.

Review of the M&RP specifically assessed in this analysis indicates that the following administrative alternatives are appropriate for consideration: rejection (no action) on significant environmental grounds or approval after specific requirements have been met.

Alternative sites for surface facilities, mining technology and methods, coal transport methods, and rates of production on individual operations were considered where appropriate, but no such modifications have been proposed or identified which would significantly reduce the adverse impacts of coal production from the region. Any new alternatives surfaced by the review process will be carefully considered.

Development of alternative sources of energy, energy conservation, federal development of the coal, and emphasis on coal development in other regions of the nation are more appropriate for consideration on a national rather than a regional basis. These evaluations are made in the draft coal programmatic statement (December 15, 1978).

Regional Alternatives

Alternatives available in regard to coal development in this region fall into several broad categories:

Rejection (No Action). This means nonapproval or or rejection of the pending M&RPs on federal leases along with any related permits or rights-of-way. It would not affect continued development of nonfederal coal or federal coal being produced on leases for which mine plans have already been approved. (However, federal coal could be made available under approved short-term competitive standards to maintain ongoing coal development.) Analysis of impacts of the no federal action alternative is discussed as the low-level scenario later in this chapter.

Defer Further Federal Coal Development Pending Demonstration of Successful Reclamation. Under this alternative, further federal coal development in the Eastern Powder River Basin would be deferred until it could be demonstrated that areas disturbed by mining activities can be reclaimed to the standards of the Surface Mining Control and Reclamation Act (SMCRA).

Past reclamation attempts in the region have had some success (see Chapter 4, Vegetation). To date, the Wyoming Department of Environmental Quality has not released any area as being satisfactorily reclaimed. This may be partially explained by the fact that a bond is not released until a minimum of 5 years passes after completion of reclamation.

It is estimated that an initial judgment on reclamation success could be made in 3 to 5 years after reclamation begins. However, reclamation efforts would be monitored by the authorized agencies, and the final acceptance would be based on SMCRA standards.

Delaying federal coal development in the region would postpone the impacts discussed in Chapter 4. If revegetation could not be accomplished, the following impacts would occur.

1. The mining companies would be forced to shut down their operations.

2. Shut-down of the mines would cause loss of employment for most of the employees and partial loss of investment in material needed to open and operate the mines.

3. Areas disturbed during the period of mining would be unreclaimed, or at best only partially reclaimed.

4. The reduction in labor force and earnings would cause socioeconomic impacts in the region.

Specific Modifications or Requirements. On a regional basis, no generally applicable modifications or requirements which will significantly mitigate predicted impacts have been identified. However, the site-specific portion of the ES considers specific modification or requirements to mitigate impacts due to implementation of the Buckskin M&RP. Any modification or requirement suggested in the public review will be carefully considered.

Alternative To Phase Mining and Reclamation Plan Approval. Several public comments were received which indicated a need for an alternative which would limit, reduce, or mitigate in some way the identified impacts related to socioeconomics. This alternative is prepared in response to those comments.

Phasing of any future coal development approvals by either the Department of the Interior or the State of Wyoming in conjunction with city, county, and state development plans could reduce some impacts identified in the proposed action. Adjustment of Department of the Interior diligence requirements would probably be required in some cases. However, relaxation of the diligence requirements may require an amendment to the Mineral Leasing Act of 1920, as amended. This alternative would limit approval of M&RPs to be consistent with the degree of socioeconomic impacts which a given town, community, or area can be expected to reasonably accommodate.

The phasing of approval of M&RPs would occur over a number of years and could extend beyond the 1990 time period. No attempt is made in this alternative to rank all those proposed or potential M&RPs which may be under consideration in the future or to suggest a possible approval schedule.

This approach to approval would take into consideration impacts of socioeconomics, transportation of coal, and other significant resource impacts which might be expected to occur. It could also be coordinated with possible federal aid programs and/or state financial assistance for which affected towns or areas would be qualified.

By selecting this alternative to the proposed action, growth pressures in communities near the proposed mines could be reduced to a level which those communities could reasonably be expected to accommodate during the life of any approved mine. Controlled production rates would stabilize, and possibly reduce, the number of trains needed to haul coal and, in turn, may reduce the waiting time at grade crossings, the number of vehicle-train collisions, and the frequency of noise and amount of air pollution from passing coal trains.

While the impacts of this alternative would depend on the objectives identified for the phasing period, the following would be expected to occur. Impacts to air quality Prevention of Significant Deterioration and the National Ambient Air Quality standards, and to soils, vegetation, wildlife, agriculture, and cultural resources would occur, but the degree of intensity would be reduced, and the impacts would continue at this lesser intensity. Air quality impacts (specifically fugitive dust) would be reduced in proportion to any reduction in the amount of coal produced. Impacts on soils, vegetation, and agriculture would still occur, but would be reduced according to the lesser amount of disturbance for any given year. Impacts on water resources would be in proportion to the level of development and the resulting human population increase. Impacts to wildlife habitat would be of the same type and would occur in proportion to the amount of habitat disturbance authorized. Impacts to wildlife populations from authorized mining activities would be variable, depending on the selection of sites. Human impacts on wildlife populations would increase in proportion to any human population increases. Cultural resource impacts would be expected to occur in proportion to the area authorized for disturbance.

Fish and Wildlife Mitigation Alternatives. The recommendations which follow would reduce or eliminate the major impacts to existing fish and wildlife resources described in Chapter 4.

(1) All mining areas would be reclaimed to wildlife habitat as soon as feasible. Reclamation would be in conformance to the postmining land use established by the State of Wyoming (Department of Environmental Quality) and/or the Bureau of Land Management or the Forest Service. Vegetative planting and reclamation would be accomplished in consultation with the Wyoming Game and Fish Department. The goal of reclamation should be to achieve the highest possible wildlife carrying capacity at the earliest possible date, using all reasonable means.

(2) Approximately 53,000 acres of land lying in a suitable area where public domain (or private land under cooperative agreement) is available should be set aside amd managed intensively for fish and wildlife resources. Selection of such an area should be accomplished in consultation with the Wyoming Game and Fish Department. The area set aside should be managed to increase its wildlife carrying capacity by at least 50%. Management tools such as water development, fertilization, vegetative manipulation, spraying, transplanting, seeding, protection of wildlife cover and management of livestock grazing to enhance wildlife habitat should be implemented as necessary. The habitat should be controlled by the surface-management agency and wildlife by the Wyoming Game and Fish Department.

(3) It would be provided that a mine permit will not be granted on land critical to the ecological requirements of the bald or golden eagle. A team of qualified biologists from the U.S. Fish and Wildlife Service, the Wyoming Game and Fish Department, and the Bureau of Land Management or the Forest Service will judge and recommend the areas to be excluded from mining. A mine permit could be granted if regulations are adopted to provide for buffer zones and alternate prey bases and nesting sites, and if that acreage critical to the eagle is not affected.

Production Levels. A "best estimate"as to the probable production level was used as a basis for evaluation of cumulative impacts from coal development within the

region. Actual production levels attained will depend partly on demand as well as on the availability of coal. Factors influencing production levels in the region include access and economics in relation to other coal sources, transportation, local and state as well as federal approvals, and pollution control requirements and technology. As previously indicated, availability of the coal resource to meet market demands or production could well occur at a significantly lower or higher level than the identified probable level. These alternate production scenarios are evaluated in the remainder of this chapter for impact.

NO-ACTION ALTERNATIVE (LOW-LEVEL SCENARIO)

Since the no-action alternative and the low-level scenario use the same coal production levels and data, they are presented together as the no-action alternative (low-level scenario).

The no-action alternative presents an assessment of a level of coal development which is lower (low-level scenario) than the most probable level described and analyzed in the first seven chapters of this ES. No action is disapproval of the federal proposed action (Buckskin Mine) presently before the Department of the Interior. The no-action alternative also assumes future disapproval of all Department of the Interior authorizations for new coal mining proposals through the year 1990.

This would mean no further approval of mining and reclamation plans, no consideration of preference right lease applications, and no development of presently unleased federal coal. However, for coal being produced from existing mines, land use authorizations necessary for facilities to transport or convert coal to other forms of energy could be considered.

The no-action alternative (low-level scenario) presents a cumulative analysis of impacts of all coal activities not dependent on new coal mining in the region, plus other regional activity. Cumulative impacts of the fourteen mines which are presently operating or pending approval (under study in separate site-specific ESs) are included. (Cumulative impacts of this level of mining were originally analyzed in the final environmental statement on the Eastern Powder River Coal Basin of Wyoming (FES 74-55).) Annual coal production from these fourteen mines would increase from 44.6 million tons in 1978 to 111.0 million tons in 1980, 165.6 million tons in 1985, and 170.3 million tons in 1990. Increasing production is attributed to mines which have only recently been approved and are still being developed to full planned production. Further information on these mines is presented in Table R8-1. Other coal-related activities include a new power plant, a coal gasification plant, and a new major rail line. Other major regional development includes oil and gas, uranium, transmission line construction, and municipal development as discussed in Chapter 1.

Tables R8-2, R8-3, R8-4, and R8-5 define, derive, and summarize the acreage and water requirements for the no-action (low-level scenario) alternative. Assumptions and analysis guidelines used in developing the analysis of the low-level scenario are the same as those in the first chapter (see Assumptions and Analysis Guidelines, Chapter 1).

Impact Analysis

The impacts of the no-action alternative (low-level scenario) are analyzed at two levels: (1) the impacts of development and continuation of the fourteen existing coal mines, and (2) the cumulative impacts of all development in the region under the low-level scenario. The analysis of the no-action alternative (low-level scenario) focuses on impacts which differ significantly from those discussed in Chapter 4 and, therefore, the reader is directed to that chapter for additional detail on the general character of impacts.

Air Quality

Emissions and Modeling Procedures. The emission sources examined for the low-level scenario are surface coal mines, uranium mines, two coal-fired power plants, a coal gasification plant, towns, and transportation. The locations of the low level developments are shown on Map 1, Appendix A. The particulate emissions from the coal and uranium mines are listed in Table R8-6. The estimated particulate, sulfur oxide (SO_x) and nitrogen oxide (NO_x) emissions from the Dave Johnston and Wyodak power plants, the Panhandle Eastern gasification plant, and the towns of Gillette, Moorcroft, Douglas, Glenrock, and Casper are shown in Table R8-7. The emissions from the mines and towns were calculated using the assumptions and procedures summarized in Chapter 4, Air Quality. The emission rates for the two power plants and the gasification plant were taken from the sources listed in Chapter 4.

The increase in vehicular emissions was not included in the dispersion modeling because it is anticipated that their impact on regional air quality would not be significant. In addition, emissions were not quantified for oil and gas development in the region. No specific information concerning possible locations of new oil and gas development was available.

Coal Development in the Low-Level Scenario. The primary effect of surface mining of coal would be to increase emissions of pollutants at the mines. Since most of the fugitive dust generated by mining operations consists of relatively large-diameter particles, most particle deposition occurs within a few miles of each mine.

Concentrations which follow refer to the contributions from the coal development in the low-level scenario. These concentrations do not include the baseline levels nor contributions from other activities.

The major TSP impact from the coal mines would be in southeast Campbell County, where five mines lie in a strip approximately 22 miles long and 2½ miles wide. From 1980 to 1990, annual TSP concentrations in this area would increase 5 micrograms per cubic meter ($\mu g/$

TABLE R8-1

LOW LEVEL OF COAL DEVELOPMENT (EXISTING COAL MINING) BY 1990 IN THE EASTERN POWDER RIVER BASIN

Projects	Annual Coal Production (MM Tons/Year)				Time Frame		
	1978	1980	1985	1990	Construction Start Up	Full Mine Operation	Mine Life (Years)
Existing Mines							
Operating Mines							
Wyodak	0.9	2.5	2.5	2.5	1922	1979	98
Dave Johnston	3.2	3.2	3.2	3.2	1958	1970	43
Belle Ayr	18.5	20.0	20.0	20.0	1973	1985	23
Cordero	9.2	20.0	24.0	24.0	1976	1981	25
Rawhide	3.0	9.0	12.0	12.0	1977	1982	40
Black Thunder	5.8	13.7	20.0	20.0	1978	1983	40
Jacobs Ranch	2.6	10.7	15.7	15.4	1975	1984	23
Kerr-McGee #16	1.0	4.2	4.2	4.2	1978	1979	14
Eagle Butte	0.3	13.2	20.0	20.0	1976	1984	39
Environmental Statement In Progress							
Caballo	0.1	3.0	7.0	12.0	1977	1987	39
Coal Creek	0	4.0	10.0	10.0	1979	1983	36
East Gillette	0	4.0	11.0	11.0	1979	1982	35
Rochelle[1]	0	0	11.0	11.0	1982	1984	29
Pronghorn	0	3.5	5.0	5.0	1979	1981	22
TOTAL	44.6	111.0	165.6	170.3			

TABLE R8-1
(cont'd)
LOW LEVEL OF COAL DEVELOPMENT (EXISTING COAL MINING) BY 1990 IN THE EASTERN POWDER RIVER BASIN

Projects	Total Permit Acres[2]	Federal Coal Acres	Total Surface to be Disturbed By 1990[3]	Average Acres Disturbed Per Year[4]	Acres Reclaimed By 1990
Existing Mines					
Operating Mines					
Wyodak	3,240	1,880	363	50	243
Dave Johnston	13,990	9,660	2,760	80	1,565
Belle Ayr	5,960	2,440	1,947	165	1,643
Cordero	8,390	6,560	3,174	285	1,820
Rawhide	5,720	5,457	755	80	410
Black Thunder	8,280	5,884	1,285	175	975
Jacobs Ranch	4,960	4,352	1,760	170	1,345
Kerr-McGee #16	960	0	559	57	572
Eagle Butte	4,470	3,520	1,208	85	611
Environmental Statement In Progress					
Caballo	7,850	5,330	1,220	195	805
Coal Creek	9,605	5,800	1,270	185	808
East Gillette	3,440	3,440	1,100	77	990
Rochelle	5,000	10,820	873	160	555
Pronghorn	2,640	4,000	455	45	310
TOTAL	84,505	69,143	18,729	1,809	12,652

TABLE R8-1
(cont'd)
LOW LEVEL OF COAL DEVELOPMENT (EXISTING COAL MINING) BY 1990 IN THE EASTERN POWDER RIVER BASIN

EMPLOYMENT[5]

Projects	1980 Construction	1980 Permanent	1985 Construction	1985 Permanent	1990 Construction	1990 Permanent
Existing Mines						
Operating Mines						
Wyodak	0	48	0	55	0	55
Dave Johnston	0	135	0	135	0	135
Belle Ayr	0	255	0	334	0	334
Cordero	0	166	0	277	0	277
Rawhide	0	322	0	430	0	430
Black Thunder	0	350	0	500	0	500
Jacobs Ranch	0	212	0	250	0	250
Kerr-McGee #16	0	123	0	123	0	125
Eagle Butte	0	200	0	350	0	350
Environmental Statement In Progress						
Caballo	121	195	0	430	0	430
Coal Creek	194	55	0	250	0	250
East Gillette	5	110	5	161	0	161
Rochelle	200	190	0	190	0	190
Pronghorn	0	226	0	279	0	279
TOTAL	520	2,597	5	3,764	0	3,766

TABLE R8-1
(cont'd)
LOW LEVEL OF COAL DEVELOPMENT (EXISTING COAL MINING) BY 1990 IN THE EASTERN POWDER RIVER BASIN

Projects	Estimated Number of Unit Trains for the Years[6] 1980	1985	1990	Market Area
Existing Mines				
Operating Mines				
Wyodak	45[7]	45[7]	45[7]	Mine mouth (Wyodak), South Dakota
Dave Johnston	0[7]	0[7]	0[7]	Mine mouth (Dave Johnston Power Plant)
Belle Ayr	2,000	2,000	2,000	Colorado, Texas, Arkansas, Kansas, Ohio, Iowa
Cordero	2,000	2,400	2,400	Wyoming, Texas
Rawhide	900	1,200	1,200	Iowa, Indiana
Black Thunder	1,370	2,000	2,000	Texas
Jacobs Ranch	1,070	1,570	1,540	Arkansas, Louisiana
Kerr-McGee #16	420	420	420	None
Eagle Butte	1,320	2,000	2,000	Southern, midwestern, and Ohio Valley states
Environmental Statement In Progress				
Caballo	300	700	1,200	Nebraska, Michigan, Indiana
Coal Creek	400	1,000	1,000	Texas
East Gillette	400	1,100	1,100	None
Rochelle	0[7]	0[7]	0[7]	None
Pronghorn	350	500	500	Minnesota, Iowa, Wisconsin, Illinois, Gulf Coast states
TOTAL	10,575	14,935	15,405	

TABLE R8-1
(cont'd)
LOW LEVEL OF COAL DEVELOPMENT (EXISTING COAL MINING) BY 1990 IN THE EASTERN POWDER RIVER BASIN

Source: Mine information was developed from mining and reclamation plans currently on file with the Area Mining Supervisor, Geological Survey.

[1] Additional federal coal lease reserves are anticipated to be mined as a part of this operation in the future, which may extend indicated mine life.

[2] All acreage within the area of operations for the mine.

[3] Only acreage disturbed by mining operations. By 1990, 3,404 additional acres will be disturbed by mine facilities.

[4] Average annual rate for new surface disturbance by mining activity.

[5] Employment data in the mining and reclamation plans were updated where possible by personal communication with the mining companies.

[6] One unit train equals 100 cars, each car having a capacity of 100 tons of coal. Does not include return traffic. Coal exported from the region is shipped south, east, or southeast.

[7] This number does not represent full transport of the mine production by unit train. Coal consumed at mine mouth is generally transported short distances by truck or private rail.

TABLE R8-2

CUMULATIVE DEVELOPMENT FOR THE REGION
LOW LEVEL OF DEVELOPMENT

	1978	1980	1985	1990
Coal Mining				
Number of Coal Mines*	10	14	14	14
Coal Mine Support Facilities:				
Miles of Rail Spurs	39	55	55	55
Miles of Telephone Lines	30	50	50	50
Miles of Access Roads	7	19	19	19
Miles of Conveyor System	0	7	7	7
Miles of Power Lines	76	93	93	93
Coal-Related Development				
Number of Power Plants**	2	2	2	2
Number of Gasification Plants	0	0	1***	1
Miles of Railroad Line				
Main Line (common-carrier)	26	113	113	113
Private	0	0	40	40
Uranium				
Cumulative Number of Uranium Mines	3	6	12	12
Cumulative Number of Uranium Mills	2	3	7	7
Cumulative Number of In-Situ Uranium Leaching Projects	0	0	1	1
Oil and Gas				
Area of Activity (acres)	4,800	4,880	5,110	5,250
Other				
Miles of New 230-kv Transmission Lines	0	0	87	87
Population Increase (1,000s)****	0	3	17	21

Note: 1978 base, and based on industry plans and indicated trends.
* Counts East Gillette and Kerr McGee #16 individually.
** Wyodak and Dave Johnston.
*** Under construction.
**** Centaur Management Consultants, Inc. 1978. Based on projection model for Campbell and Converse counties (University of Wyoming 1978). Population increases represent increased population over the 1978 base population (37,780).

TABLE R8-3

SUMMARY OF CUMULATIVE ACREAGES DISTURBED AND RECLAIMED BY COAL MINING ACTIVITY
LOW LEVEL OF DEVELOPMENT

	Cumulative Acreage 1978	1980	1985	1990
Surface Mine Operations	2,515	4,712	12,677	18,729
Power Lines	451	558	558	558
Rail Spurs	859	1,155	1,155	1,155
Access Roads	128	228	228	228
Conveyor Systems	0	70	70	70
Mine Structures	1,039	1,360	1,360	1,360
Relocations	36	36	36	36
Totals: Acres Disturbed	5,028	8,119	16,084	22,136
Acres Reclaimed	1,234	3,495	9,887	12,652
Difference	3,794	4,624	6,197	9,484

Note: For average acreage requirements, please refer to Table R1-4.

TABLE R8-4

CUMULATIVE ACREAGE DISTURBED AND RECLAIMED BY ALL DEVELOPMENT ACTIVITIES
LOW LEVEL OF DEVELOPMENT

	1978	1980	1985	1990
Acreage Disturbed				
Coal Mining Activity*	5,028	8,119	16,084	22,136
Power Plants	2,000	2,000	2,000	2,000
Coal Gasification	0	0	1,500	1,500
Railroad Line				
Main Line	546	2,373	2,373	2,373
Private	0	0	840	840
Uranium	5,000	6,200	15,300	21,800
Oil and Gas	4,800	4,880	5,110	5,250
Sand, Gravel, Scoria	200	200	620	1,280
230-kv Transmission Line	0	0	1,566	1,566
Population**	0	419	2,540	3,142
TOTAL	17,574	24,191	47,933	61,887
Acreage Reclaimed				
Coal Mining Activity*	1,234	3,495	9,887	12,652
Other Activities	900	2,400	6,550	13,300
TOTAL	2,134	5,895	16,437	25,966
Difference	15,440	18,296	31,496	35,921

Note: For average acreage requirements, refer to Table R1-4.
* From Table R8-3.
** Acreage required for population increase over 1978 base municipal acreage.

TABLE R8-5

INCREASED WATER USAGE FOR THE REGION
LOW LEVEL OF DEVELOPMENT

Annual Water Requirements (acre-feet)

Type of Use	1975	1978	Inc.*	1980	Inc.*	1985	Inc.*	1990	Inc.*
Coal Mines	170	980	810	2,120	1,950	3,320	3,150	3,420	3,250
Irrigation	10,000	10,000	0	10,000	0	10,000	0	10,000	0
Municipal**	3,990	7,030	3,040	7,640	3,650	10,360	6,370	11,100	7,110
Oil Field (water-flood)	12,000	12,000	0	12,000	0	12,000	0	12,000	0
Uranium Mines	80	140	60	230	150	400	320	425	345
Uranium Mill	500	4,200	3,700	6,200	5,700	13,200	12,700	16,200	15,700
In-Situ Leaching Project	0	0	0	0	0	225	225	115	225
Power Plants***	7,500	7,630	130	7,630	130	7,630	130	7,630	130
Gasification Plant	N/A	N/A	N/A	N/A	N/A	7,000	7,000	7,000	7,000
Stock Water and Domestic	10,000	10,000	0	10,000	0	10,000	0	10,000	0
Totals	44,240	51,980	7,240	55,820	11,580	74,135	29,895	78,000	33,760
Sewage**** (Based on 70% of municipal use)	2,800	5,060	2,260	5,290	2,610	6,710	3,910	7,710	4,410

Note: Please see Table R1-7 for water use requirement factors.
* Increase over base year (1975).
** Includes need for projected population increase in region.
*** Includes Wyodak air-cooled and Dave Johnston water-cooled plants.
**** Not a part of cumulative total.
N/A = not applicable

TABLE R8-6

PARTICULATE EMISSIONS (TONS/YEAR) FROM MINING ACTIVITY IN THE LOW-LEVEL SCENARIO

Mine	Year 1980	1985	1990
Coal Mines			
Rawhide	1,596	2,026	2,218
Eagle Butte	2,077	3,222	3,096
East Gillette	1,670	1,531	1,492
Kerr McGee #16	765	1,200	1,240
Wyodak	406	434	682
Caballo	606	1,598	3,651
Belle Ayr	5,024	4,289	4,520
Pronghorn	801	1,628	1,769
Cordero	10,448	9,241	9,241
Coal Creek	1,481	3,432	3,432
Jacobs Ranch	2,431	2,754	3,149
Black Thunder	3,717	4,743	3,744
Dave Johnston	1,356	1,068	961
Rochelle	0	2,428	2,318
Uranium Mines			
Highland	1,763	2,655	3,425
Bear Creek	854	890	885
Morton	883	1,635	1,770
Bill Smith	854	910	910
Potential Mine	0	855	890
Potential Mine	0	0	855

TABLE R8-7

EMISSONS OF PARTICULATES, SO_x, AND NO_x FROM COAL-RELATED ACTIVITIES AND URBAN AREAS (TONS/YEAR)

Source	Pollutant	Year 1980	1985	1990
Coal-Related Activities				
Wyodak Power Plant	Particulates	1,755	1,755	1,755
	SO_x	14,100	14,100	14,100
	NO_x	11,227	11,227	11,227
Dave Johnston Power Plant	Particulates	18,542	18,542	18,542
	SO_x	19,637	19,637	19,637
	NO_x	19,053	19,053	19,053
Panhandle Eastern Coal Gasification Plant	Particulates		1,376	1,376
	SO_x		11,884	11,884
	NO_x		13,667	13,667
Towns (Low-Level Scenario)				
Gillette	Particulates	248	380	482
	SO_x	263	402	511
	NO_x	1,434	2,179	2,778
Moorcroft	Particulates	51	80	99
	SO_x	44	69	84
	NO_x	252	402	489
Glenrock	Particulates	62	102	91
	SO_x	47	73	73
	NO_x	328	500	507
Douglas	Particulates	124	274	241
	SO_x	99	219	193
	NO_x	686	1,500	1,325
Casper	Particulates	2,146	2,493	2,905
	SO_x	2,358	2,745	3,190
	NO_x	6,913	8,041	9,709

m^3). The maximum 24-hour concentrations would increase 17 $\mu g/m^3$. TSP increases above baseline would drop to near zero at distances greater than 10 miles from the mine boundaries. By 1990, interactions between the emissions from adjacent mines should cause annual TSP concentrations in the area between the mines to rise 10 $\mu g/m^3$. Maximum 24-hour concentrations in this section of the region in 1990 are predicted to be in the 21 to 34 $\mu g/m^3$ range. The annual TSP concentration from the existing mines alone would not exceed the state standard of 60 $\mu g/m^3$ except possibly within the mine boundaries.

Any potential violations discussed above would not occur with application of the new prevention of significant air quality deterioration (PSD) regulations (43 CFR 118).

Coal Development and Other Major Activities of the Low-Level Scenario. The emission sources included in this category are the uranium mines, power plants, oil and gas development, and municipal facilities as well as the previously mentioned coal mines.

Concentrations mentioned in this section refer to the total air quality (including rural baseline) due to the entire low-level scenario.

Predicted annual TSP concentrations are shown on Figures R8-1, R8-2, and R8-3. Significant TSP concentrations would occur in southeast Campbell County which encompasses five coal mines. In this area, annual TSP concentration would be 30 $\mu g/m^3$ (6 $\mu g/m^3$ above the rural background concentration). Concentrations would reach 35 $\mu g/m^3$ in the area between mines situated close to one another. The increase in TSP concentration would drop to 1 $\mu g/m^3$ beyond 10 miles from any of the mines.

Two uranium mines would significantly impact air quality. These mines are close enough for their emissions to interact with one another and also interact with emissions from the Dave Johnston Power Plant and the Panhandle Eastern Gasification Plant. In a 2-mile wide strip between the Highland and Morton Ranch mines (north of Glenrock) the TSP levels would reach 30 $\mu g/m^3$. The maximum 24-hour concentrations around these two mines and those discussed above is estimated to be 103 $\mu g/m^3$. The annual and 24-hour Wyoming air quality standards of 60 $\mu g/m^3$ and 150 $\mu g/m^3$ might be exceeded at the boundary of some of the existing mines.

Again, with the new interpretation of fugitive dust in 43 CFR 118, it is unlikely that the above violation would occur.

Emissions due to Gillette's population growth and interactions with emissions from the Rawhide and Eagle Butte mines (north of Gillette) would be expected to produce annual TSP concentrations of 30 $\mu g/m^3$. The impact would be confined to the area containing Gillette and the two mines. Concentrations nearer to Gillette are expected to reach 35 $\mu g/m^3$ in 1980 and 1985 and 40 $\mu g/m^3$ in 1990. The maximum 24-hour TSP concentrations would occur in Gillette. A 24-hour maximum concentration of 129 $\mu g/m^3$ is predicted in 1985 and 136 $\mu g/m^3$ in 1990. It is possible that Wyoming's 24-hour TSP standard (150 $\mu g/m^3$) might be violated in downtown Gillette, but unlikely that the national primary standard of 260 $\mu g/m^3$ would be reached.

TSP concentrations surrounding the towns of Moorcroft, Douglas, and Glenrock for the low-level scenario would be small in 1980 and 1985. In 1990, Moorcroft and Glenrock TSP concentrations should reach 30 $\mu g/m^3$.

The annual and short-term sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) concentrations surrounding Gillette due to population growth associated with the low-level scenario are expected to increase significantly during the study years. Annual SO_2 concentrations of 8 $\mu g/m^3$ in 1980 would increase to 23 $\mu g/m^3$ in 1990. A maximum 24-hour concentration of 78 $\mu g/m^3$ and 3-hour concentration of 129 $\mu g/m^3$ are predicted to occur in 1990. Although these are relatively large increases they are all below the Wyoming annual standard of 60 $\mu g/m^3$, the 24-hour standard of 260 $\mu g/m^3$, and the 3-hour standard of 1,300 $\mu g/m^3$. Annual NO_2 concentrations surrounding Gillette would increase from 30 $\mu g/m^3$ in 1980 to 60 $\mu g/m^3$ in 1990. These levels are well below the federal and state standards of 100 $\mu g/m^3$. Predicted annual gaseous pollutant concentrations are shown on Figures R8-4 through R8-9.

Near Glenrock, interaction with emission from the Dave Johnston Power Plant would produce an annual SO_2 concentration of 8 $\mu g/m^3$ and an NO_2 concentration of 20 $\mu g/m^3$ in 1990. Similar concentrations would occur in the vicinity of Douglas due to interaction with emissions from the Panhandle Eastern Gasification Plant. The gasification plant and power plant would not cause significant increases in TSP, NO_2, or SO_2 concentrations, but their small influence is felt over a large area.

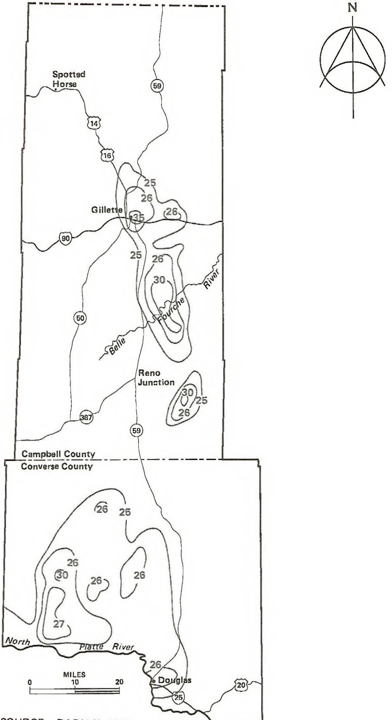
The annual and short-term NO_2 and SO_2 concentrations surrounding Moorcroft would be small during the study period. See Table R8-8 for the maximum short-term concentration of TSP and SO_2 for the town.

Emissions from diesel locomotives required to carry coal from the existing mines would not cause a significant rise in the regional TSP, SO_2, or NO_2 concentration.

The air quality impact of commuter traffic for the existing mines is not expected to measurably increase regional TSP, NO_2, or carbon monoxide concentrations. These emissions would be relatively small and would be highly variable on an hourly basis.

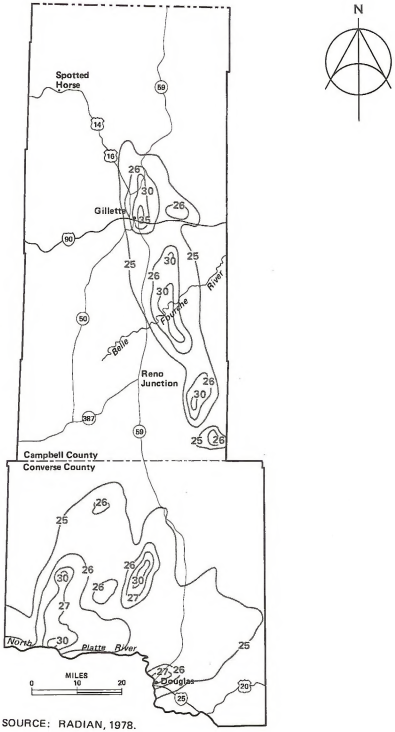
Away from towns and mines, the average annual horizontal visibility related to atmospheric particulates is expected to remain near the regional baseline of 54 miles. The mean annual horizontal visibility would drop to 48 miles near the areas of the region that include (1) the five coal mines in southeast Campbell County, (2) the Highland and Morton Ranch uranium mines north of Glenrock and, (3) Gillette and the Eagle Butte and Rawhide mines north of Gillette. The annual visibilities in Gillette are estimated to decrease from 40 miles in 1980 to 35 miles in 1990. The visibility near Gillette during the period of highest predicted 24-hour TSP concentrations would be approximately 17 miles in 1990.

The Chapter 8 Technical Report, on file at the Casper District Office of the Bureau of Land Management, con-



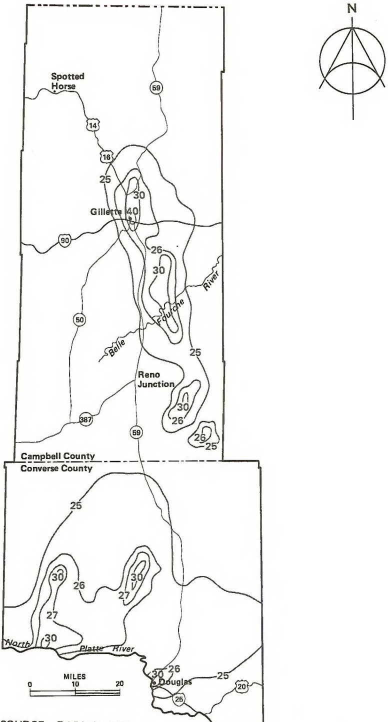
SOURCE: RADIAN, 1978

Figure R8-1
ANNUAL TSP CONCENTRATIONS (μg/m^3)
FOR THE LOW LEVEL SCENARIO FOR 1980



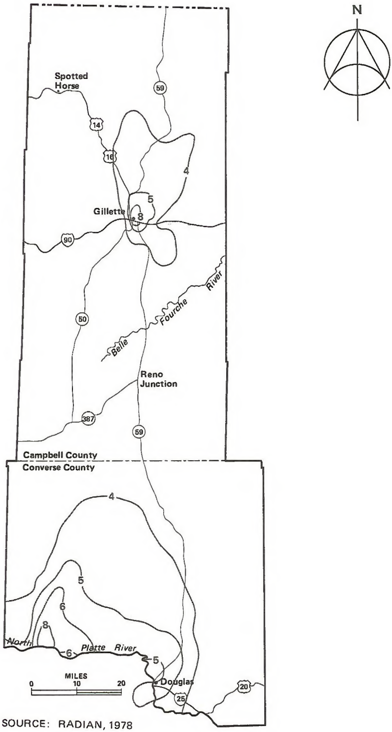
SOURCE: RADIAN, 1978.

Figure R8-2
ANNUAL TSP CONCENTRATIONS (µg/m³) FOR THE LOW LEVEL SCENARIO FOR 1985



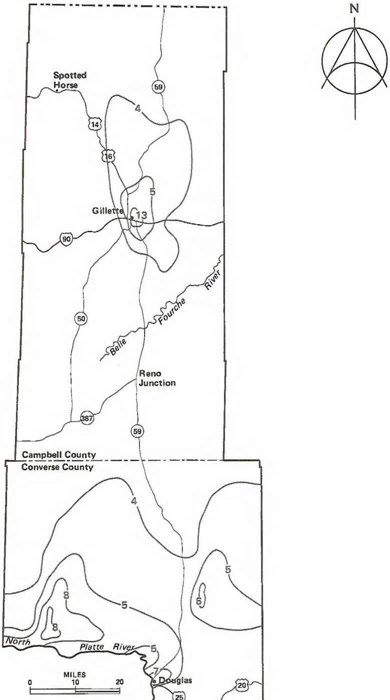
SOURCE: RADIAN, 1978

Figure R8-3
ANNUAL TSP CONCENTRATIONS (μg/m³) FOR THE LOW LEVEL SCENARIO FOR 1990



SOURCE: RADIAN, 1978

Figure R8-4
ANNUAL SO_2 CONCENTRATIONS ($\mu g/m^3$)
FOR THE LOW LEVEL SCENARIO FOR 1980



SOURCE: RADIAN, 1978

Figure R8-5
ANNUAL SO_2 CONCENTRATIONS ($\mu g/m^3$) FOR THE LOW LEVEL SCENARIO FOR 1985

TABLE R8-8

ANNUAL AND MAXIMUM SHORT-TERM CONCENTRATIONS ($\mu g/m^3$) PREDICTED AROUND TOWNS IN THE REGION FOR THE LOW-LEVEL SCENARIO WITH THE NATIONAL AND WYOMING AIR QUALITY STANDARDS ($\mu g/m^3$)

Town	Pollutant	Averaging Period	1980	1985	1990	National Standards Primary	National Standards Secondary	Wyoming Standard
Gillette	TSP	Annual	35	35	40	75	60	60
	TSP	24-hour	119	119	136	260	150	150
	SO_2	Annual	8	13	23	80	-	60
	SO_2	24-hour	27	44	78	365	-	260
	SO_2	3-hour	45	73	129	-	1,300	1,300
Moorcroft	TSP	Annual	26	26	30			
	TSP	24-hour	88	88	102			
	SO_2	Annual	4	6	8			
	SO_2	24-hour	14	20	27			
	SO_2	3-hour	22	34	45			
Douglas	TSP	Annual	26	27	30			
	TSP	24-hour	88	92	102			
	SO_2	Annual	5	7	8			
	SO_2	24-hour	17	24	27			
	SO_2	3-hour	28	39	45			
Glenrock	TSP	Annual	27	30	30			
	TSP	24-hour	92	102	102			
	SO_2	Annual	8	8	8			
	SO_2	24-hour	27	27	27			
	SO_2	3-hour	45	45	45			

Note: Standards for averaging times less than one year are not to be exceeded more than once a year.

tains additional TSP, SO_2, and NO_2 analyses of the low-level scenario discussed above.

Topography

Alteration of topography under the probable level of development is described in Chapter 4.

Under the low-level scenario, topography would be altered by coal mining in the following amounts for the time frames indicated.

1980—4,712 acres at 14 mine sites (.09% of the region) or 21 acres less than at the most probable level.

1985—12,677 acres at 14 mine sites (.30% of the region) or 257 acres less than at the most probable level.

1990—18,729 acres at 14 mine sites (.38% of the region) or 377 acres less than at the most probable level.

Of the above acreages, the following amounts would be reclaimed to a more gentle, smoother surface generally 10 to 40 feet lower than now exists.

1980—3,495 (.07% of the region) or the same as at the most probable level.

1985—9,887 (.20% of the region) or the same as at the most probable level.

1990—12,652 (.30% of the region) or 14 acres less than at the most probable level.

The following areas would remain in pit and spoil pile topography.

1980—1,217 (.02% of the region) or 21 acres less than at the most probable level.

1985—2,790 (.06% of the region) or 257 acres less than at the most probable level.

1990—6,077 (.12% of the region) or 363 acres less than at the most probable level.

Topography would be altered at uranium mines and quarry sites (sand, gravel, and scoria). Acreages disturbed and reclaimed by these activities are discussed in Chapter 4 and would not change under the low-level scenario.

Oil and gas activities cause only slight alteration of the topography. Areas thus disturbed and reclaimed are also discussed in Chapter 4 and would not change under the low-level scenario.

Topography would be changed only slightly by coal-related development and at mine support facility sites (average of 200 acres per mine). The main impact of these activities would be at cut and fill sites to maintain grade along access roads and railroads. Acres disturbed by roads and railroads under the low-level scenario would be 3,756 acres in 1980 (141 less than at the probable level), and 4,596 acres in 1985 and 1990 (141 less than at the probable level).

Disturbance would occur along 187 miles of access roads and railroads in 1980 and 227 in 1985 and 1990 (8 less than at the most probable level of 195 miles in 1980 and 235 in 1985 and 1990).

Figures for total acres disturbed by all regional development may be found in Table R8-4 for the low-level scenario.

Geology

The impacts of strip mining on geology for the probable level of development are described in Chapter 4.

Under the low-level scenario about 10,683,445 acre-feet of geologic record (82,725 acre-feet less than at the probable level) would be lost. The beneficial impact of exposure of geologic sections to scientific examination would be slightly less than at the probable level.

Paleontology. Some fossil-bearing formations would be destroyed. The beneficial impact of exposure of fossil materials for scientific examination would be slightly less than at the probable level.

Soils

Future population increases in the region would result in the removal of soil from several thousand acres by the year 1990 (see Table R8-4). This permanent loss of soil surface would result from the construction of housing and support facilities. Also, an increase in population would result in greater use of the region's soils for recreation, particularly off-road vehicle use. The amount of impact on soils that would result from recreation is unknown.

Major disturbance and alteration of soils as a result of mining would cause a reduction in soil productivity on the affected soils. Chapter 4 describes the various processes resulting in loss of soil productivity.

For a summary of cumulative acreages disturbed and reclaimed by coal mining activity under the low level of development, refer to Table R8-3.

For a summary of cumulative acreages disturbed and reclaimed by all regional development activities under the low level of development, refer to Table R8-4.

Water Resources

Groundwater. Although coal mining would disturb the alluvium, overburden, and coal beneath 22,136 acres by 1990, based on existing mine plans, aquifers would be destroyed on less than 18,900 acres. The difference is because part of the coal and overburden where the Wyodak seam would be mined is not saturated, and apparently none of the coal and bedrock overburden at the Dave Johnston Mine is saturated. Mining may be disallowed on some parts of existing mines by application of SMCRA regulations; the acreage is not known.

Water levels would be lowered in the lateral equivalents of the aquifers destroyed, because water would flow from the aquifers into the mine pits. The lowering of water levels would be small a short distance from each pit, because the alluvial and overburden aquifers are water-table aquifers. Therefore, lowering cannot exceed the thickness of the individual aquifers, and lowering which approximates the aquifer thickness would occur only at the face of a pit.

Water in the coal is, in places, under artesian conditions. Where these conditions occur, water levels could be lowered more than the thickness of the coal. However, all the water would not necessarily drain to the

bottom of the pit, because shale partings, which commonly occur in coal, impede vertical movement of water.

The best example of impacts of mining on water levels in the coal is shown in Figure R4-10. The two northern depressions in the water-level surface are natural discharge points. The southern depression is where the water surface is graded toward the Wyodak Mine. There are ten mines in operation or under construction, and there may be four more by 1985. A depression in the water surface, such as that west of Wyodak, would develop at each mine except Dave Johnston.

The lowering of the water level in the coal and overburden aquifers would affect water levels in some nearby wells and decrease natural discharge. However if wells or springs are adversely impacted by mining, the impact can be mitigated by drilling wells into aquifers below the coal.

Water levels would be lowered an unknown amount in aquifers below the coal by development for municipal and potable mine supplies. Gillette has determined that their well field, tapping the Fort Union Formation, is adequate to serve only the present population, and they are planning a new well field, tapping the Madison Limestone northeast of Gillette to supply the increased demand. Interference between wells of the mines would be negligible, because potable supplies required at the mines would be relatively small, the wells would be widely spaced, the formations beneath the coal are thick, and the individual aquifers are lenticular.

Reclamation would begin within 2 to 3 years after mining at most mines, and the long-term groundwater conditions would begin to be established. Water-table conditions would occur in the reclaimed areas, and a study by Rahn (1976) indicates that the spoil may be able to yield water as well as the aquifers it replaces. The small seeps that occurred on some hillsides would not be replaced, because the spoil would not have the relatively continuous shale layers that resulted in perched water.

Recharge would probably be increased in the reclaimed areas over original levels. Although the permeability of the soil may decrease, reclamation practices to retain moisture and prevent erosion would increase infiltration, as would decrease in the mean slope of the land surface, which would generally occur. An increased infiltration, combined with destruction of the shale layers, would result in greater recharge.

Water in spoil in the reclaimed areas south of the Belle Fourche River would probably have nearly the same head relationship to adjoining aquifers as do the aquifers they replace, because the land surface would be reclaimed to nearly the same elevation. In some reclaimed areas north of the Belle Fourche, the land would be reclaimed to a lower elevation than that of the original water level in the coal, and the original conditions could not be restored. In reclaimed areas north and east of Gillette the discharge points from the coal would be the new edge of coal. However, the shape of the water surface would be essentially the same as shown in Figure R4-10.

Where broad, low-lying areas remain after reclamation in discharge areas, there would probably be more opportunity for subirrigation than there was along the original, or would be along the reclaimed, alluvial valleys. Some streams may become perennial or intermittent downstream from the reclaimed areas, if recharge is in fact increased. If there is less bulking of spoil than anticipated or if there is long-term compaction, waterlogging of land could be the major adverse impact.

The quality of water in the spoil in recharge areas would be poorer than the quality that occurred in most of the preexisting aquifers. However, because the chemical environment would not be changed in the adjoining aquifers, water moving from the spoil into adjoining aquifers would undergo reactions such that common ions and trace elements dissolved in the water would be the same as before mining a short distance from the mine.

In areas where bedrock aquifers, including coal, discharge into spoil, the water moving into the spoil would increase in dissolved constituents, and it would be similar to that in alluvial aquifers in the area.

One coal gasification project is anticipated to be in operation by 1990. Large quantities of water would be required (see Tables R8-5 and R1-7), and the groundwater sources being considered include water from the Madison Limestone and the Lance Formation and Fox Hills Sandstone. Until the quantity and source of groundwater that would be used is known, no estimate of impacts on groundwater supply can be made. Further, other environmental impacts cannot be assessed without a description of what by-products, if any, would be allowed to enter into the hydrologic system.

The impacts of uranium mining, particularly with regard to potential hazard to quality of groundwater, require additional study. However, in the southern part of the region, which is the principal uranium area, the sandstone aquifers are, apparently, better aquifers than those to the north. Also, ranchers have reported (personal communications) that mining and milling operations have caused decreased flow in one stream and cessation of flow in at least one well.

The impacts on water resources are not all negative, however, as dewatering of one uranium mine has resulted in perennial flow in a reach of the stream below the mine. This has benefited agriculture by making irrigation possible along the stream. Similar conditions may occur elsewhere with the opening of new mines.

Groundwater use for irrigation, secondary and tertiary recovery of oil, and stock and domestic use is not expected to increase. Projected water use for the region with low-level development is shown in Table R8-5.

Surface Water. The low level of development would result in a level of impact insignificantly smaller than that shown in Chapter 4. See Table R4-4 for estimates of some impacts. Those headed "all activity"are essentially the same as those of the low-level scenario; the differences (due to Buckskin Mine activity) are so small that they are well within the errors of the predicted values.

Vegetation

Terrestrial.

Coal Mining. All activities related to development and continuation of the coal mines in the low-level scenario would result in the disturbance of native vegetation on 8,119 acres by 1980, 16,084 acres by 1985, and 22,136 acres by 1990. (See Table R8-3.) Approximately 0.4% of the region's surface acreage would be disturbed by existing coal activity by 1990. Lands disturbed by coal activity and reclaimed would total about 3,495 acres by 1980, 9,887 acres by 1985, and 12,652 acres by 1990.

All Development Activity. All activities related to the development of new coal mines, the continuation of the existing coal mines, plus all the other energy-related activities would result in the disturbance of native vegetation on 24,191 acres by 1980, 47,933 acres by 1985, and 61,887 acres by 1990 (see Table R8-4). Approximately 1.0% of the region's surface acreage would be disturbed by all this activity by 1990. Lands disturbed from all activity and reclaimed would total about 5,895 acres by 1980, 16,437 acres by 1985, and 25,966 acres by 1990.

Additional disturbance of vegetation would occur due to increased outdoor recreation (particularly off-road vehicle travel).

The revegetation of disturbed areas would be difficult due to many factors (Cook et al. 1974, May 1975, Thames 1977). Climatic conditions are severe, with a lack of moisture possibly being the most limiting factor (May 1975). Secondary succession plant species would compete with seeded plants for moisture and nutrients (James and Cronin 1974, Klingman 1971). Rodents would cause problems on revegetated areas by consuming seeds and by girdling seedlings (Thames 1977). Also there could be a loss of soil productivity as soils are rearranged, which would further limit revegetation success.

Reclaimed areas would usually be grassland for many years. Shrub and forb reestablishment would require extensive plant succession. Cook and others (1974) suggested a period of 10 to 30 years for native plant reestablishment in semiarid rangelands (providing supplemental irrigation is not used).

Young, palatable plants produced by revegetation efforts would attract livestock and wildlife. The grazing of the young plants would inhibit growth vigor and could cause a delay in the establishment of vegetative cover.

The destruction of vegetation from wildfire is expected to cause a yearly impact on the vegetation resource. The incidence of lightning fires is expected to remain relatively constant, while the number of man-caused fires is expected to increase in proportion to population increase. Within that premise, the number of man-caused wildfires projected for benchmark periods of 1980, 1985, and 1990 are 77, 95, and 112 respectively. Acreage of vegetation that would be destroyed by all wildfires annually for the same benchmark periods is estimated at 4,515, 5,545, and 6,568 acres respectively.

Haul road dust and fugitive coal dust resulting from mining operations may be deposited on vegetation adjacent to the mine areas. Dust-covered vegetation would be less palatable to livestock and wildlife.

Another impact from the destruction of vegetative cover could be the invasion of noxious weeds or other less palatable species of vegetation onto the disturbed areas. These weedy species would compete with seeded species and could inhibit the establishment of desired permanent vegetative cover.

The short-term and long-term losses of vegetative cover and production from disturbance activities would affect numerous living and nonliving components of the environment (see other sections in this chapter).

Aquatic. Aquatic habitats that would be impacted by mineral developments are not extensive. Mining would eliminate aquatic habitats in certain localized areas (see the site-specific analysis). In nearby offsite areas, aquatic habitats in groundwater-fed ponds would probably be eliminated due to lowered aquifer levels.

Surface runoff from disturbed areas could increase the sediment load into streams. This increase would degrade the aquatic community and destroy individual plants by suffocation and the abrasive effects of increased siltation.

Endangered and/or Threatened Species. There is no record of any endangered or threatened plant species in the region; therefore no impact would be anticipated.

Fish and Wildlife

Table R8-9 summarizes the impacts on terrestrial wildlife habitat and populations by the fourteen existing mines and the cumulative total of all regional development including the coal mines. Fish populations in Little Thunder Creek, Caballo Creek, Reno Reservoir No. 1, and Caballo Reservoir would still be lost. Overall impacts under this scenario would be slightly less than those projected for the most probable level of development. See Chapter 4, Fish and Wildlife, for a detailed analysis of the effects of development on fish and wildlife habitat and populations.

Cultural Resources

The number of sites which may be disturbed or destroyed by activities under the low-level scenario cannot be quantified at this time; however compliance with Executive Order 11593 and Section 2(b) of the Historic Preservation Act would ensure mitigation of impacts of cultural resources which may be affected by much of the development activity.

Visual Resources

Regional development in the low-level scenario would affect visual resources in the region to an insignificantly slighter degree than the probable level of development. Those alterations in the landscape expected through 1990 are discussed in Chapter 4.

Recreation Resources

Compared with the probable level of development, the low-level scenario would reduce projected regional

TABLE R8-9

WILDLIFE POPULATION AND PROGENY LOSSES
LOW-LEVEL SCENARIO

	1980	1985	1990
BIRDS			
Nongame	111,595	371,880	678,235
Raptors	125	365	605
Game			
Waterfowl	0	3,120	4,165
Turkey	0	10	15
Sharp-tailed Grouse	905	2,815	4,930
Sage Grouse	1,690	5,235	9,155
Hungarian Partridge	165	550	1,090
Mourning Dove	2,895	9,910	18,200
MAMMALS			
Nongame	930,740	3,806,860	7,387,210
Furbearers/Predators			
Beaver	100	255	430
Muskrat	0	1,310	1,910
Mink	35	90	155
Coyote	125	455	815
Bobcat	5	15	30
Small Game			
Desert Cottontail	5,450	20,025	37,635
Showshoe Hare	250	805	1,535
Big Game			
Pronghorn	195	560	945
Mule Deer	115	340	585
White-tailed Deer	1	1	3

(Campbell and Converse counties) population increases, and hence recreation participation, by only 4% by 1990. This difference would be considered negligible both by residents of the region and by agencies and municipalities responsible for providing and maintaining recreation facilities. Changes already occurring in recreation styles and participation are discussed in Chapter 4.

Agriculture

Livestock Grazing.

Coal Mining. All activities related to the development and continuation of coal mining in the low-level scenario would remove vegetation from an estimated 8,119, 16,084, and 22,136 acres by 1980, 1985, and 1990 respectively. Livestock forage lost due to these activities would be 1,624 animal unit months (AUMs) by 1980, 3,217 AUMs by 1985, and 4,427 AUMs by 1990. (See Table R8-3.)

All Development Activity. All activities related to the development and continuation of the coal mines, plus all the other energy-related activities would remove native vegetation from an estimated 24,191, 47,933, and 61,887 acres by 1980, 1985, and 1990 respectively. Livestock forage lost due to these activities would be 4,838 AUMs by 1980, 9,586 AUMs by 1985, and 12,377 AUMs by 1990.

The loss of AUMs due to these activities would be detrimental to the region's livestock industry but would not significantly affect production of livestock, since the majority of the AUMs would not be permanently lost. Reclamation would be conducted on an estimated 42% (25,966 acres) of the acreage which would be disturbed by 1990 (61,887 acres or 1.2% of the region's acreage).

Besides direct loss of livestock forage, other impacts associated with population increases, as discussed in Chapter 4, could occur.

The development of mines and the construction of facilities such as access roads and rail spurs would divide grazing areas, disrupt grazing-use patterns, cause access problems to livestock water areas, increase the costs of caring for the livestock, and possibly alter land ownership patterns.

Mine development could cause some loss of stock watering facilities for the duration of mining activities. This could result in nonuse of grazing areas, if their location is remote from remaining water sources. Wells developed on mining sites for use in mine operations could be put to beneficial use in livestock operations when the disturbed lands are reclaimed and returned to full production.

Fugitive dust from overburden material could contain trace elements toxic to plants and/or animals. Long-term contamination of adjacent rangelands could result (Thames 1977).

Farming. The development of energy-related minerals at the low-level scenario would result in the loss of crop-producing lands as shown in Table R8-10.

Prime and Unique Farmland. As yet there are no areas delineated in the region as prime farmland (see Chapter 4, Agriculture, Prime and Unique Farmland).

Mineral Resources

Under the low-level scenario, coal resources consumed in 1979-80 would be 178 million tons (4 million tons less than under the probable level); from 1981-1985, coal resources consumed would be 735 million tons (about 14 million tons less at than the probable level); and from 1986-1990, 846 million tons would be consumed (20 million tons less than at the probable level). By 1990, more than 1,852.38 million tons (2.5% of the minable and 8.9% of the strippable coal resources of the region) would have been consumed. Consumption of other mineral resources such as uranium, sand, gravel, and scoria is discussed in Chapter 4, and there would be no change in those estimates for the low-level scenario.

Transportation Networks

Railroads. Coal and noncoal freight train flowing through or out of the Eastern Powder River Basin under the low-level scenario is shown in Tables R8-11 and R8-12. Impacts of railroad traffic on communities which lie along the railroad lines would be slightly (less than 2 trains per day) less than those described in Chapter 4.

Highways. The following highway improvements are planned for northeastern Wyoming whether or not additional coal development occurs. Future freeway improvement would include the completion of the unfinished portion of Interstate 25 and second-stage surfacing and upgrading as necessary. Federal and state highways would be upgraded and improved as necessitated by increases in use. U.S. Highway 26/87 would be improved southeast of Orin Junction for 2.5 miles with grading, drainage structures, and paving. The bridge over Spotted Horse Creek, northwest of Gillette, is scheduled for replacement on U.S. Highway 14/16.

State Highway 59 would be widened and surfaced from Reno Junction north for 8 miles. State Highway 387 would be widened and improved for 6.6 miles east from the Johnson County line. This project would include grading, drainage structures, and asphalt. Extension of State Highway 450 (Clareton Road) from Clareton to Reno Junction is proposed. As part of the project, grading, drainage structures, and asphalt are planned from Highway 59 east for 15 miles and from the Weston County line west for 6 miles. The total proposed length of the new road is 35 miles, and its purpose is to disperse the work forces and population from Gillette and Reno Junction to the Upton and Newcastle area (personal communication, Oliver Sundby, Wyoming Highway Department 1977), and to provide better access to the coal fields. This project would be partially funded by the coal companies, and was a mitigating measure from the previous Eastern Powder River Basin Environmental Statement (FES 74-55).

In addition to being maintained and improved, county roads would be expanded as the population increases in rural areas. The county would take over, develop, improve, and maintain existing private roads as expansion needs require; and also build new roads to serve growth areas, especially in those areas that require school bus

TABLE R8-10

SUMMARY OF PROJECTED LOSS OF AGRICULTURAL LAND AND PRODUCTION AT LOW-LEVEL SCENARIO

	Land Removed From Crop Production (Based On Total Acres Disturbed)		Annual Hay Production Lost (Tons)			Annual Dryland Wheat Lost (Bushels)	Other Cropland Lost (Acres)	
Year	(Acres) Dryland	(Acres) Irrigated	Dryland .78 Tons/Acre	Irrigated 1.62 Tons/Acre	Total Tons	18.6 Bushel/Acre	Dryland	Irrigated
1980								
Coal Mining	162	48	67	58	125	1,089	18	12
All Activities	565	167	232	203	435	3,783	62	41
1985								
Coal Mining	237	70	98	85	183	1,588	26	17
All Activities	1,034	306	426	373	799	6,931	115	75
1990								
Coal Mining	480	142	198	173	371	3,216	53	35
All Activities	1,401	415	577	505	1,082	9,389	155	102

TABLE R8-11

ANNUAL UNIT COAL TRAIN VOLUME
LOW-LEVEL SCENARIO

	1980 Number of Unit Trains*	1985 Number of Unit Trains	1990 Number of Unit Trains	Market Destination**
Existing Mines				
Operating Mines				
Wyodak	45***	45***	45***	South Dakota, mine mouth (Wyodak Power Plant)
Dave Johnston	0***	0***	0***	Mine mouth (Dave Johnston Power Plant)
Belle Ayr	2,000	2,000	2,000	Colorado, Texas, Indiana, Missouri, Kansas, Oregon, Arkansas
Cordero	2,000	2,400	2,400	Texas, Wyoming
Rawhide	900	1,200	1,200	Nebraska, Indiana
Black Thunder	1,370	2,000	2,000	Nebraska, Oklahoma, Texas
Jacobs Ranch	1,070	1,570	1,540	Arkansas, Louisiana, Oklahoma
Eagle Butte	1,320	2,000	2,000	Southern, Midwestern, and Ohio Valley states
Kerr-McGee #16	420	420	420	Unknown

TABLE R8-11
(cont'd)

ANNUAL UNIT COAL TRAIN VOLUME
LOW-LEVEL SCENARIO

	1980 Number of Unit Trains*	1985 Number of Unit Trains	1990 Number of Unit Trains	Market Destination**
Environmental Statement in Progress				
Caballo	300	700	1,200	Unknown
Coal Creek	400	1,000	1,000	Unknown
East Gillette	400	1,100	1,100	Arkansas, Louisiana
Rochelle	0	0***	0***	Wyoming
Pronghorn	350	500	500	Unknown
Total	10,575	14,935	15,405	

1980 daily average = 10,575 trains per year ÷ 365 = 29.0 trains per day eastbound (loaded)
29.0 trains per day westbound (empty)
1985 daily average = 14,935 trains per year ÷ 365 = 40.9 trains per day eastbound (loaded)
40.9 trains per day westbound (empty)
1990 daily average = 15,405 trains per year ÷ 365 = 42.2 trains per day eastbound (loaded)
42.2 trains per day westbound (empty)

Source: Table R1-2.

* A unit coal train usually consists of 100 coal cars and 5 diesel units. Each car carries 100 tons of coal.
** Based on Western Oil Reporter February 1978.
*** This number does not represent full transport of the mine production by unit trains. Coal consumed at mine mouth is generally transported short distances by truck or private rail.

TABLE R8-12

DAILY TRAIN VOLUME PROJECTIONS FOR THE REGION
LOW-LEVEL SCENARIO

Train Type	1980* Number of Trains**	1980* Percent of Total	1985 Number of Trains**	1985 Percent of Total	1990 Number of Trains**	1990 Percent of Total
Northern Route						
Total Coal Trains:	66.8	91.8	54.7	90.1	56.0	90.3
Eastern Powder River Basin Coal Trains***	55.8	76.7	43.7	72.0	45.0	72.6
"Other" Coal Trains****	11.0	15.1	11.0	18.1	11.0	17.7
Non-coal Freight Trains*****	6.0	8.2	6.0	9.9	6.0	9.7
Total Coal and Non-coal Freight Trains	72.8	100.0	60.7	100.0	62.0	100.0
Southern Route						
Total Coal Trains:	0	0	43.7	84.5	45.0	84.9
Eastern Powder River Basin Coal Trains***	0	0	43.7	84.5	45.0	84.9
"Other" Coal Trains	0	0	0	0	0	0
Non-Coal Freight Trains	8	100.0	8.0	15.5	8.0	15.1
Total Coal and Non-Coal Freight Trains	8	100.0	51.7	100.0	53.0	100.0

* Train traffic expected on the Burlington Northern route in early 1980 before the Donkey Creek to Orin Junction rail strip is completed. If the rail strip were completed in 1980, about half of the coal trains originating in the Eastern Powder River Basin would move south toward Orin Junction.

** Includes both loaded and empty train traffic.

*** See Table R1-2.

**** Burlington Northern estimate of coal trains in Gillette in 1982, personal communication, Jerrold G. Wood, Director of Public Works 1978.

***** Burlington Northern freight traffic estimate for the Donkey Creek to Edgemont rail segment in 1978 and 1982, personal communication, Jerrold G. Wood, Director of Public Works 1978.

service. Bureau of Land Management and Forest Service roads would be upgraded as deemed feasible and necessary because of increased use for recreation.

There were 109,629 registered cars and trucks in 1975, or almost one car or truck for each person living in the eight northeastern counties of Wyoming in 1975. (Based upon a total 1975 population of 115,900, total car and truck registrations amounted to 95% of population figures.) Projections for the low-level scenario were made for 1980, 1985, and 1990 upon the assumption that the basic percent relationship between vehicle registrations and population within the region would remain constant. By 1980, 1985, and 1990, there would be 154,523, 180,618, and 198,504 increase in registered vehicles respectively in the eight counties (Table R8-13).

Air Service. Two regional airports are planning expansion or improvements to handle current demand, as well as that projected under the low-level scenario.

In 1976, Converse County finished a $30,000 survey on moving the county airport to a different site 2 miles north of Douglas, where there would be more room for expansion if needed. If approved, and if federal funds are available, the new facility would be completed sometime between 1980 and 1985. The new facility would have two runways, one with a length of 7,000 feet and enough room to expand 2,000 feet, and another with a length of 5,000 feet (Harbridge House 1976).

In Campbell County, the Gillette-Campbell County Airport has applied for a planning grant from the Federal Aviation Administration to see what changes are needed in the future, which could include changing the location of the airport. If approved, the study would be completed in 12 to 18 months. Demand forecasts and present inventories, which would determine the adequacy or inadequancy of the present site, should be completed after 4 months. New and improved navigation and communication equipment has been installed. It is hoped an advanced instrument landing system can be installed in the future (personal communication, Sam Stafford 1977).

All airports in northeast Wyoming would be upgraded as increased demands on the facilities dictate and as necessary funds become available.

Other. Impacts of the low-level of coal development on bus service would be virtually indistinguishable from those discussed in Chapter 4.

Socioeconomic Conditions

Sociocultural Impacts. The lower population level projected for the low-level scenario would mean sociological impacts that are slightly reduced from those outlined in Chapters 2 and 4. The relationship would not necessarily be proportionate. That is, all impacts would probably not decrease by the same percentage as the population change, because some impacts tend to compound themselves and add to other impacts. The degree of impact reduction is therefore difficult to predict.

Economic Impacts.

Population. Table R8-13 contains local and regional low-level scenario population projections. Since the actual level of coal development in the Eastern Powder River Basin is likely to be much higher than that foreseen under the low-level scenario, these estimates could be regarded as a lower limit to future population growth in northeastern Wyoming.

Despite the conservative assumptions made regarding future levels of coal development, the projections in Table R8-13 foresee a continued rapid growth in the population of Campbell County and Gillette between 1978 and 1990. During this period Campbell County's population is anticipated to grow from 26,080 to 38,853, an average annual rate of change of 3.4%. Gillette, meanwhile, would grow from 20,450 to 32,983 inhabitants (an average 4.1% annual increase). Both the county and Gillette would experience their most rapid rate of annual population increase between 1982 and 1983 (3.8% and 4.7% per year respectively).

Converse County and the towns of Douglas and Glenrock would experience major population growth during the period under study, largely as a result of the projected coal gasification plant to be built northeast of Douglas. This population boom is expected to peak around 1985, when Converse County would have a population of over 21,000, and Douglas would have over 15,000 inhabitants. Thereafter, Converse County and Douglas both would face a decline in population as the coal gasification plant's large construction work force is disbanded and replaced with a smaller operating staff. Glenrock, which would receive fewer of the gasification plant construction workers, would experience more moderate population growth between 1978 and 1985, but would avoid a drop in population after the gasification plant is completed in 1985-1986. However, population growth in Glenrock would level off at only 0.3% annually between 1985 and 1990.

Crook County and the town of Moorcroft would also experience significant population growth under the low-level scenario. The population of Crook County should grow from 5,148 to 6,809 between 1978 and 1990 (an increase of 2.4% annually), while Moorcroft would be expected to grow from 1,200 to 2,851 inhabitants over the same period (an average annual increase of 7.5%). The projected population of other counties and municipalities would not differ substantially from that discussed in Chapter 4.

Employment. Table R8-14 contains low-level scenario employment projections for the eight-county region. Summarizing, business and consumer services would remain the predominant sources of employment through 1990, although their percent share in total employment should decline somewhat during this period (i.e., from 50.0% to 46.6%). Primarily under the influence of coal development, minerals extraction is projected to increase its relative share in total employment between 1978 and 1980 (i.e., from 17.8% to 19.0%). While declining in its relative share of total employment after peaking in 1980, mining employment is projected to show continued moderate growth in absolute terms through the end of the decade. Construction employment should peak in 1985 due to the projected construction of a gasification plant in Converse County, then decline in both relative and

TABLE R8-13
POPULATION PROJECTIONS, 1978-1990
LOW-LEVEL SCENARIO

County City	1978	1980	Annual Rate of Change* 1978-1980	1985	Annual Rate of Change* 1980-1985	1990	Annual Rate of Change* 1985-1990	Annual Rate of Change* 1978-1990
Campbell	26,080	28,175	(3.8)	33,878	(3.8)	38,853	(2.8)	(3.4)
Gillette	20,450	22,258	(4.3)	28,008	(4.7)	32,983	(3.3)	(4.1)
Other Areas	5,630	5,867	(2.1)	5,870	**	5,870	**	(0.3)
Converse	11,700	13,019	(5.5)	21,065	(10.1)	19,726	(-1.3)	(4.4)
Douglas	7,500	8,368	(5.6)	15,006	(12.4)	13,595	(-2.0)	(5.1)
Glenrock	2,700	3,137	(7.8)	4,542	(7.7)	4,614	(0.3)	(4.6)
Other Areas	1,500	1,514	(0.5)	1,517	**	1,517	**	(0.1)
Crook	5,148	5,434	(2.7)	6,292	(3.0)	6,809	(1.6)	(2.4)
Moorcroft	1,200	1,482	(11.1)	2,334	(9.5)	2,851	(4.1)	(7.5)
Other Areas	3,948	3,952	**	3,958	**	3,958	**	**
Johnson	6,803	6,862	(0.4)	7,212	(1.0)	7,624	(1.1)	(1.0)
Buffalo	4,400	4,455	(0.6)	4,799	(1.5)	5,211	(1.7)	(1.4)
Other Areas	2,403	2,407	**	2,413	**	2,413	**	**
Natrona	73,588	74,965	(0.9)	82,882	(2.0)	92,079	(2.1)	(1.9)
Casper	50,579	51,116	(0.5)	54,203	(1.2)	57,789	(1.3)	(1.1)
Other Areas	23,009	23,849	(1.8)	28,679	(3.8)	34,290	(3.6)	(3.4)
Niobrara	3,020	3,045	(0.4)	3,133	(0.6)	3,219	(0.5)	(0.5)
Lusk	2,000	2,021	(0.5)	2,103	(0.8)	2,189	(0.8)	(0.8)
Other Areas	1,020	1,024	**	1,030	**	1,030	**	**
Sheridan	22,501	23,713	(2.7)	27,347	(2.9)	31,666	(3.0)	(2.9)
Sheridan	13,400	14,608	(4.4)	18,230	(4.5)	22,549	(4.3)	(4.4)
Other Areas	9,101	9,105	**	9,117	**	9,117	**	**
Weston	6,932	7,493	(4.0)	8,315	(2.1)	8,976	(1.5)	(2.2)
Newcastle	3,455	4,012	(9.8)	4,828	(3.8)	5,489	(2.6)	(4.0)
Other Areas	3,477	3,481	**	3,487	**	3,487	**	**
Region	155,772	162,656	(2.2)	190,124	(3.2)	208,952	(1.9)	(2.5)

Source: University of Wyoming 1978.
* Average rate of change compounded annually.
** Average rate of change less than 0.1 %.

TABLE R8-14

EMPLOYMENT PROJECTIONS BY SECTOR
1978-1990
LOW-LEVEL SCENARIO

	1978*		1980		1985		1990	
	No.	% Total	No.	% Total	No.	% Total	No.	% Total
Agriculture	1,669	(3.3)	1,685	(3.1)	1,698	(2.7)	1,698	(2.5)
Minerals Extraction	9,064	(17.8)	10,883	(19.9)	11,920	(18.8)	12,749	(19.0)
Construction	4,167	(8.2)	4,436	(8.1)	6,249	(9.9)	4,837	(7.2)
Manufacturing	2,764	(5.4)	2,867	(5.3)	3,101	(4.9)	3,337	(5.0)
Railroads	182	(0.4)	321	(0.6)	583	(0.9)	635	(0.9)
Business/ Consumer Services	25,408	(50.0)	26,288	(48.2)	29,370	(46.4)	31,308	(46.6)
Government/ Education	7,575	(14.9)	8,093	(14.8)	10,416	(16.4)	12,579	(18.7)
Military	22	**	22	**	22	**	22	**
Total***	50,851	100.0	54,586	100.0	63,359	100.0	67,165	100.0

Source: University of Wyoming 1978.

* 1978 employment figures represent first quarter employment only. Unlike 1978 population estimates, which have been benchmarked to current population estimates provided by local communities, differing definitions of employment utilized by the University of Wyoming's model and the Wyoming Employment Security Division precluded using state employment data as a benchmark for model-generated employment projections.

** Less than 0.1%.

*** Totals may not add to 100.0% due to rounding.

absolute terms through 1990. Among the other sectors of the regional economy, agriculture should continue to decline in relative importance as a source of employment through 1990, from 3.3% in 1978 to 2.5% by 1990. Manufacturing is projected to decline from 5.4% to 5.0% of total employment during the period under study. Railroad employment would increase slightly, from 0.4% to 0.9% of regional employment. Government employment should show considerable absolute and relative increases (from 14.9% to 18.7% of total employment).

Projected regional employment would be mirrored to varying degrees among the individual counties, but the percentages of workers employed in the various sectors under the low-level scenario should not differ substantially from those shown in Chapter 4.

The above discussion actually understates the importance of coal mining as a source of regional employment, since many jobs in the construction, and business and consumer services sectors are indirectly dependent on purchases by the coal companies and their employees.

Table R8-15 displays estimates of direct and indirect coal-related employment by county, in terms of numbers of workers and as percentages of total county employment. For the region as a whole, coal-related employment is expected to increase as a percentage of total employment between 1978 and 1990, i.e., from 8.8% to 19.3%. In other words, approximately 52% of the total projected increase in employment between 1978 and 1990 would be attributable to coal.

Among individual counties, Campbell would be the most highly dependent upon coal-related employment (i.e., 1,909 or 26.8% of county employment in 1978, increasing to 4,621 or 39.2% by 1990). In addition, coal-related employment would be highly important in Crook County (rising from 342 or 23.2% of total employment in 1978, to 709 or 33.8% by 1990). Coal-related employment would account for more than 20% of total employment in two other counties by 1990: Converse (26.6% by 1990, compared with 9.1% in 1978), and Weston (22.0% in 1990, versus 11.6% in 1978). Coal-related employment is also projected to increase as a percentage of total employment in the other four counties. By 1990, the degree of dependency on coal-related employment in these four counties would range from a low of 1.0% (Niobrara) to a high of 13.0% (Natrona). Coal-related employment shown for Johnson, Niobrara, and Sheridan counties would consist mostly of indirect and induced employment rather than direct mine employment. (This assessment is limited to impacts of Campbell and Converse county coal mines and hence does not include employment of Sheridan County residents in Montana or Sheridan County coal mines.)

Income. Table R8-16 contains low-level scenario earnings projections for the eight-county region. Total earnings in the region would be expected to rise from $631.1 million in 1978 to $1,200.5 million in 1990, a total increase of 90.2% or 5.5% annually. (All figures are expressed in 1975 equivalent dollars.) It is anticipated that business and consumer services would remain the predominant source of earnings in the region as a whole through 1990, followed in second place by minerals extraction. However, business and consumer services is expected to decline from 42.1% of total regional earnings in 1978 to 38.7% in 1990, while minerals extraction should increase from 22.5% to 25.2% of total earnings between 1978 and 1990. Construction should continue as the third largest source of regional earnings at least through 1985 (when it should account for 15.9% of total earnings), then decline to 11.3% as planned energy construction projects are completed. By 1990, government/education would have replaced construction as the third largest source of regional earnings, contributing 16.9% of the total. Agriculture would continue to decline in relative importance, from 2.4% of regional earnings in 1978, to 1.7% in 1990. Manufacturing would also decline in relative importance as a source of regional earnings between 1978 and 1990, from 6.6% to 5.2%.

Trends in projected earnings on the individual county level would mirror these regionwide developments to varying degrees, but are not expected to differ substantially from those discussed in Chapter 4.

As an aid in assessing the overall importance of the coal industry to the regional economy, Table R8-17 presents estimates of earnings generated by coal-related activities under the low-level scenario. Coal-related activities are defined here not only as direct mining activities, but also indirect and induced activity generated by mine expenditures and miners' personal consumption expenditures.

On a regionwide basis, coal-related earnings are projected to increase from $65.5 million (10.4% of total earnings) in 1978 to $209.1 million (21.6% of total earnings) by 1985. Thereafter, between 1985 and 1990, coal-related earnings should continue to grow in absolute terms (i.e., to $223 million), but decline somewhat in relative terms to 18.6% of total regional earnings. (All dollar figures are expressed in 1975 dollars.)

The largest absolute share of projected coal-related earnings would be concentrated in Campbell County, which is expected to obtain $66.4 million or 40.6% of total county earnings from coal-related activities by 1985. In 1990, Campbell County would earn $81.7 million (36.2% of total earnings) from coal-related activities.

In 1985, Converse County would receive the largest relative share of total earnings from coal-related activities, $57.4 million or 47.0% of total county earnings. Between 1985 and 1990, coal-related earnings in Converse County would decline in both absolute and relative terms (to $31.1 million or 26.5% of county earnings). This decline would be largely the result of the completion of the construction of the coal gasification plant northeast of Douglas and subsequent major layoffs of construction workers.

Other counties which would receive a major share of their total earnings from coal-related sources include Crook (in which coal-related earnings should increase from 28.5% to 41.1% of total earnings between 1978 and 1985, before declining to 36.9% by 1990) and Weston. In the latter, coal-related earnings are expected to grow from 15.1% to 26.6% of total earnings by 1985, then decline slightly to 25.2% by 1990.

TABLE R8-15

PROJECTED COAL-RELATED EMPLOYMENT BY COUNTY
1978-1985
LOW-LEVEL SCENARIO

County	1978		1980		1985		1990	
	No. of Workers	As Percent of County Employment	No. of Workers	As Percent of County Employment	No. of Workers	As Percent of County Employment	No. of Workers	As Percent of County Employment
Campbell	1,909	(26.8)	2,814	(34.4)	3,884	(38.8)	4,621	(39.2)
Converse	354	(9.1)	498	(11.0)	2,623	(38.7)	1,621	(26.6)
Crook	342	(23.2)	480	(29.5)	1,137	(59.2)	709	(33.8)
Johnson	31	(1.6)	44	(2.2)	76	(3.6)	107	(4.7)
Natrona	1,300	(5.0)	1,793	(6.7)	3,025	(10.3)	4,258	(13.0)
Niobrara	3	(0.3)	4	(0.5)	6	(0.7)	9	(1.0)
Sheridan	262	(3.7)	367	(4.8)	630	(7.1)	892	(9.4)
Weston	278	(11.6)	530	(19.6)	652	(21.9)	707	(22.0)
Region	4,479	(8.8)	6,530	(12.0)	12,033	(18.9)	12,952	(19.3)

Source: University of Wyoming 1978.

Note: Employment includes direct, indirect, and induced.

* Railroad employment is included only in regional employment totals.

TABLE R8-16

PROJECTED EARNINGS BY SECTOR
(MILLIONS OF 1975 DOLLARS)
1978-1990
LOW-LEVEL SCENARIO

	1978*		1980*		1985*		1990*	
	Dollars	% Total	Dollars	% Total	Dollars	% Total	Dollars	% Total
Agriculture	15.3	(2.4)	17.7	(2.5)	18.8	(7.9)	19.9	(1.7)
Minerals Extraction	142.2	(22.5)	181.9	(25.2)	237.8	(24.5)	302.4	(25.2)
Construction	84.0	(13.3)	93.6	(13.0)	154.0	(15.9)	135.2	(11.3)
Manufacturing	41.4	(6.6)	44.4	(6.2)	52.8	(5.4)	62.5	(5.2)
Railroads	2.7	(0.4)	4.9	(0.7)	10.3	(1.1)	12.8	(1.1)
Business/ Consumer Services	265.6	(42.1)	287.6	(39.9)	361.8	(37.3)	464.0	(38.7)
Government/ Education	79.5	(12.6)	90.1	(12.5)	134.3	(13.8)	203.1	(16.9)
Military	0.4	(0.1)	0.4	(0.1)	0.5	(0.1)	0.6	(0.1)
Total**	631.1	(100.0)	720.6	(100.0)	960.0	(100.0)	1,200.5	(100.0)

Source: University of Wyoming 1978.

* Earnings estimates for 1978 and later years are based on employment projections. See Table R8-14 for additional discussion of employment projections.

** Totals may not add to 100.0% due to rounding.

TABLE R8-17

PROJECTED COAL-RELATED EARNINGS BY COUNTY
(MILLIONS OF 1975 DOLLARS)
1978-1985
LOW-LEVEL SCENARIO

County	1978 Amount	1978 As Percent of County Earnings	1980 Amount	1980 As Percent of County Earnings	1985 Amount	1985 As Percent of County Earnings	1990 Amount	1990 As Percent of County Earnings
Campbell	29.3	(31.2)	43.4	(37.3)	66.4	(40.6)	81.7	(36.2)
Converse	5.1	(10.0)	6.6	(10.4)	57.4	(47.0)	31.1	(26.5)
Crook	5.3	(28.5)	7.7	(35.1)	12.3	(41.1)	14.9	(36.9)
Johnson	0.4	(1.7)	0.5	(1.9)	1.0	(3.2)	1.4	(3.6)
Natrona	15.2	(4.8)	21.9	(6.4)	41.9	(9.7)	55.0	(9.7)
Niobrara	*	-	*	-	*	-	*	-
Sheridan	3.0	(3.7)	4.4	(4.6)	8.6	(6.7)	11.4	(7.2)
Weston	4.5	(15.1)	9.2	(25.1)	12.2	(26.6)	14.7	(25.2)
Region**	65.5	(10.4)	98.6	(13.7)	209.1	(21.6)	223.0	(18.6)

Source: University of Wyoming 1978.
Note: Earnings include direct, indirect, and induced.
* Negligible
** Rail earnings are included only in the regional earnings total.

The four counties previously discussed would derive their coal-related earnings from a combination of direct mine earnings and indirect and induced earnings generated by mine and mine worker expenditures. Coal-related earnings in the remaining four counties (Johnson, Natrona, Niobrara, and Sheridan) would consist almost entirely of indirect and induced earnings. These counties would vary with regard to the coal-related share in total county earnings, from a negligible amount in Niobrara County to 9.7% of total earnings in Natrona County in 1990.

Local Services. The impact of projected low-level scenario population growth on local services would vary widely among individual communities, depending on their current service levels and capacity of facilities, as well as the rate and magnitude of expected population growth. However, for the most part, the impacts on local services would not alter measurably from the impacts described in Chapter 4. The only exception is Gillette, which would require 29 additional police officers under this scenario by 1990, compared with the 30 officers needed to meet the demands of the cumulative population under the probable level.

Housing. Table R8-18 shows projected growth of housing demand under the low-level scenario, compared with historical growth rates in the housing stock. In Gillette, the demand for single-family housing is expected to grow at a rate of 6.0% annually between 1977 and 1990. The demand for single-family housing in Douglas, Glenrock, and Moorcroft is projected to grow at average annual rates of 3.6%, 4.6%, and 8.6% respectively. In the other communities of the eight-county region, the projected increase in demand for single-family housing would be the same as described in Chapter 4. Based on comparisons with historical rates of growth in the local stock of single-family housing, the local housing market should be able to meet the additional demand through 1990. Other aspects of the local housing situation, notably the large number of households unable to afford single-family housing, as well as the obstacles to development of housing alternatives, are discussed in Chapter 4.

Education. The following section discusses projected school district enrollments for the eight-county region for the low-level scenario (see Table R8-19). Population enrollment projections differ significantly from the enrollment projections in Chapter 4 only in Gillette.

In the Gillette School District, current building capacity plus planned expansion would bring total district capacity to 6,921 pupils by 1982, which is sufficient to meet projected enrollment increases beyond 1990. The district would also need to hire an additional 242 teachers by 1990 in order to maintain current pupil/teacher ratios, or seven fewer teachers than under the most probable scenario.

Health Care. Chapter 2 discussed the shortage of health care personnel characteristic of most northeastern Wyoming communities. Unless these communities have significantly greater success in attracting and holding new medical specialists, this shortage would be aggravated by any population increase.

Table R8-20 projects the number of additional physicians, registered nurses, and dentists required to provide recommended levels of health care to the local population through 1990. On the local as well as the regional level, these requirements do not differ measurably from those described in Chapter 4.

Present hospital facilities as well as additional facilities either under construction or planned should be sufficient to meet the projected demands of the low-level population through 1985. By 1990, however, the region would need 183 additional hospital beds (compared with the requirement for 186 beds under the probable level of development). These needs could be met through new hospital construction, or if possible, by increasing the presently low average utilization rate of existing bed facilities.

Retail Trade. Projections of retail sales on a regional or individual county basis are approximately the same as those described in Chapter 4.

Local Finances. Douglas, Glenrock, and Moorcroft, municipalities which would face potential operating deficits under the probable level of development, would experience the same operating shortfalls under the low-level scenario. Municipal governments' capital cost deficits are likewise approximately the same under the probable level of development and the low-level scenario. (See Chapter 4.)

HIGH-LEVEL SCENARIO

The high-level scenario presents a cumulative analysis of a level of coal development higher than the probable level which has been described and analyzed in the first seven chapters of this statement. The high level represents a possible level of coal production which could supply the demand indicated by industry expressions of interest which have been evidenced by past leasing, preference right lease applications, and submission of proposals in areas of interest for coal development.

Any future federal actions related to potential coal production would require additional assessment of environmental impacts. The requirements of the Surface Mining Control and Reclamation Act, the 43 CFR 3041 and 30 CFR 211 regulations, and other applicable state and federal laws and regulations would apply to potential coal development (see Chapter 3). Unsuitability criteria will be applied to all future coal actions.

In Campbell and Converse counties, there are approximately 24,000 acres of federal coal lands under lease for which mining and reclamation plans have not yet been submitted. Federal coal lease reserves and preliminary industry proposals and plans indicate the potential for six new mining projects as well as future expansion of existing mines. The federal coal leases for which mining and reclamation plans have not been submitted are shown on Map 1, Appendix A. Development potentials on these leases are summarized in Table R8-21.

There are approximately 91,000 acres of federal coal lands under preference right lease application. All preference right lease applicants in the Eastern Powder River

TABLE R8-18

PROJECTED HOUSING DEMAND
1978-1990
LOW-LEVEL SCENARIO

Community/ Housing Type	1977 Housing Stock	Average Annual Growth Rate of Housing Stock 1970-77*	Demand for Additional Housing Units Beyond Current Stock: 1978-1990 Total No. of Units	Demand for Additional Housing Units Beyond Current Stock: Average Annual Growth of Housing Stock Required 1978-90*
Gillette**				
Single-family	1,623	5.2%	1,857	6.0%
Multi-unit	680	6.3%	486	4.2%
Mobile	1,542	13.3%	1,492	5.3%
Total all types	3,845	8.1%	3,835	5.5%
Douglas				
Single-family	1,232	6.5%	721	3.6%
Multi-unit	207	0.7%	350	7.9%
Mobile	349	24.8%	1,206	12.2%
Total all types	1,788	8.2%	2,277	6.5%
Glenrock				
Single-family	439	NA	318	4.3%
Multi-unit	63	NA	162	10.3%
Mobile	159	NA	569	12.4%
Total all types	661	3.7%	1,049	7.6%
Moorcroft				
Single-family	147	NA	285	8.6%
Multi-unit	0	NA	63	0
Mobile	150	NA	230	7.4%
Total all types	297	NA	578	8.7%

TABLE R8-18
(cont'd)
PROJECTED HOUSING DEMAND
1978-1990
LOW-LEVEL SCENARIO

Community/ Housing Type	1977 Housing Stock	Average Annual Growth Rate of Housing Stock 1970-77*	Demand for Additional Housing Units Beyond Current Stock: 1978-1990 Total No. of Units	Demand for Additional Housing Units Beyond Current Stock: Average Annual Growth of Housing Stock Required 1978-90*
Buffalo				
Single-family	1,398	4.8%	55	0.3%
Multi-unit	93	-12.0%	44	3.0%
Mobile	130	11.4%	164	6.5%
Total all types	1,621	3.3%	263	1.2%
Casper				
Single-family	12,034	2.3%	718	0.4%
Multi-unit	3,580	3.0%	376	0.8%
Mobile	655	18.1%	1,225	8.4%
Total all types	16,269	2.8%	2,319	1.0%
Lusk				
Single-family	NA	NA	17	NA
Multi-unit	NA	NA	22	NA
Mobile	NA	NA	93	NA
Total all types	720	0.2%	132	1.3%
Sheridan				
Single-family	3,993	2.1%	600	1.1%
Multi-unit	477	-3.0%	421	5.0%
Mobile	780	45.7%	1,563	8.8%
Total all types	5,250	2.4%	2,687	3.2%
Newcastle				
Single-family	950	0.4%	369	2.6%
Multi-unit	246	6.1%	81	2.2%
Mobile	172	9.9%	242	7.0%
Total all types	1,368	1.6%	592	2.8%

Note: See Table R4-24 for derivation of projections.

* Compounded annually

** 1977 figures for Gillette do not include housing located outside city limits, since comparable data for 1970 were unobtainable. Consequently, average growth rate in Gillette's housing stock 1970-77 is probably understated.

NA = Not available

TABLE R8-19

PROJECTED CUMULATIVE SCHOOL DISTRICT ENROLLMENTS
1980-1990
LOW-LEVEL SCENARIO

	1980				1985				1990			
	Elem.	J. H.	H. S.	Total	Elem.	J. H.	H. S.	Total	Elem.	J. H.	H. S.	Total
Campbell												
Gillette	2,813	1,125	844	4,782	3,388	1,355	1,016	5,759	3,885	1,554	1,165	6,604
Converse												
Douglas	1,312	469	375	2,156	2,243	801	640	3,684	2,046	730	584	3,360
Glenrock	481	222	185	888	664	306	255	1,225	673	311	254	1,263
Crook												
Sundance	714	359	334	1,407	826	415	388	1,629	894	450	419	1,763
Johnson												
Buffalo	763	334	324	1,420	802	351	340	1,493	847	371	360	1,578
Natrona												
Casper	7,271	3,298	3,523	14,092	8,039	3,647	3,895	15,581	8,932	4,051	4,377	17,310
Niobrara												
Lusk	304	155	161	621	312	160	166	639	321	164	171	656
Sheridan												
Ranchester	361	188	189	738	362	189	189	740	361	191	189	742
Sheridan	2,009	961	872	3,842	2,507	1,199	1,080	4,794	3,102	1,483	1,385	5,930
Clearmont	89	21	34	144	89	22	34	145	89	22	35	146
Weston												
Newcastle	713	324	353	1,390	792	360	391	1,543	859	390	426	1,675
Upton	245	109	104	458	272	121	116	509	291	129	124	544

Source: University of Wyoming 1978.

TABLE R8-20

PROJECTED HEALTH CARE PERSONNEL REQUIREMENTS
LOW-LEVEL SCENARIO

	1977 Physicians	Physicians Recommended Levels*			1977 Registered Nurses	Registered Nurses Recommended Level**			1977 Dentists	Dentists Recommended Level***		
		1980	1985	1990		1980	1985	1990		1980	1985	1990
Campbell	9	28	34	39	53	99	120	139	4	18	21	25
Converse	6	13	21	20	29	46	74	70	2	8	13	12
Crook	2	5	6	7	11	19	22	24	1	3	4	4
Johnson	4	7	7	8	30	24	25	27	2	4	5	5
Natrona	80	75	83	92	383	263	291	323	34	67	52	58
Niobrara	2	3	3	3	12	11	11	11	1	2	2	2
Sheridan	26	24	27	32	154	83	96	111	16	15	17	20
Weston	3	7	8	9	26	26	29	31	2	5	5	6
Region	132	163	191	210	698	571	669	736	62	102	119	131

Source: Wyoming Department of Health and Social Services 1977; personal communication, Larry Bertilson, State Health Planning Manager 1978.

* Based on recommended standard of 1,000 persons per physician.
** Based on recommended standard of 285 persons per registered nurse.
*** Based on recommended standard of 1,600 persons per dentist.

TABLE R8-21

HIGH LEVEL OF COAL DEVELOPMENT (PROPOSED, EXISTING, AND POTENTIAL COAL MINING) BY 1990

Projects	Annual Coal Production (millions of tons per year) 1978	1980	1985	1990
Site-Specific Action				
Buckskin	0	2.0	4.0	4.0
Low-Level Scenario Mines				
14 Mines	44.6	111.0	165.6	170.3
Potential Development on Existing Federal Coal Leases				
(6 new mines)	0	0	38.0	52.0
Potential Development on Preference Right Coal Lease Applications				
(10 new mines, extension of 3 existing mines, and 1 in situ coal gasification project*)	0	0	35.0	45.0
Potential Development on Areas of Interest				
(8 new mines, extension of 2 additional mines)	0	0	28.0	59.0
TOTAL	44.6	113.0	270.6	330.3

TABLE R8-21
(cont'd)
HIGH LEVEL OF COAL DEVELOPMENT (PROPOSED, EXISTING, AND POTENTIAL COAL MINING) BY 1990

	ACREAGE				
Projects	Total Permit Acres**	Federal Coal Acres	Total Surface to be Disturbed by 1990***	Average Acres Disturbed per year****	Acres Reclaimed by 1990
Site-Specific Action					
Buckskin	1,760	600	377	50	14
Low-Level Scenario Mines					
14 mines	84,505	69,143	18,729	1,809	12,652
Potential Development on Existing Federal Coal Leases					
(6 new mines)	32,000	28,000	5,000	500	1,200
Potential Development on Preference Right Coal Lease Applications					
(10 new mines, extension of 3 existing mines, and 1 in situ coal gasification project)	120,000	100,000	14,000	1,700	4,000
Potential Development on Areas of Interest					
(8 new mines, extension of 2 additional mines)	32,000	26,200	5,700	697	2,400
TOTALS	270,265	223,943	43,806	4,756	20,266

TABLE R8-21
(cont'd)
HIGH LEVEL OF COAL DEVELOPMENT (PROPOSED, EXISTING, AND POTENTIAL COAL MINING) BY 1990

Projects	EMPLOYMENT 1980 Const.	EMPLOYMENT 1980 Perm.	EMPLOYMENT 1985 Const.	EMPLOYMENT 1985 Perm.	EMPLOYMENT 1990 Const.	EMPLOYMENT 1990 Perm.	Estimated Number of Unit Trains per Year***** 1980	Estimated Number of Unit Trains per Year***** 1985	Estimated Number of Unit Trains per Year***** 1990
Site-Specific Action									
Buckskin	197	52	0	125	0	125	200	400	400
Low-Level Scenario Mines									
14 mines	520	2,597	5	3,764	0	3,766	10,575	14,935	15,405
Potential Development on Existing Federal Coal Leases (6 new mines)	0	0	400	1,500	0	1,900	0	3,800	5,200
Potential Development on Preference Right Coal Lease Applications (10 new mines, extension of 3 existing mines, and 1 in situ coal gasification project)	0	0	700	1,400	0	2,100	0	3,500	4,500
Potential Development on Areas of Interest (8 new mines, extension of 2 additional mines)	0	0	225	661	200	1,151	0	2,800	5,900
TOTALS	717	2,649	1,330	7,450	200	9,050	10,575	25,435	31,405

TABLE R8-21
(cont'd)
HIGH LEVEL OF COAL DEVELOPMENT (PROPOSED, EXISTING, AND POTENTIAL COAL MINING)
BY 1990

Projects	MARKET AREA
Site-Specific Action Buckskin	Oklahoma
Low-Level Scenario Mines (14 mines)	Mine mouth electric generation, gasification, also plains, Gulf, Ohio Valley, midwest, and southern states
Potential Development on Existing Federal Coal Leases (6 new mines)	unknown
Potential Development on Preference Right Coal Lease Applications (10 new mines, extension of 3 existing mines, and 1 in situ coal gasification project)	unknown
Potential Development on Areas of Interest (8 new mines, extension of 2 additional mines)	Largely unknown although the midwest, south central, and plains states are anticipated

* In situ gasification production not on table. Average gas production is estimated to reach 150 million cubic feet per day after 1990.

** All acreage within the area of operations for the mine.

*** Only acreage disturbed by mining operations. By 1990, 9,679 additional acres would be disturbed by mine facilities.

**** Annual average rate for new surface disturbance by mining activity.

***** One unit train equals 100 cars, each car having a capacity of 100 tons of coal. Does not include return traffic. Coal exported from the region would be shipped south or southeast.

Basin were required to make an initial showing of commercial quantities (development potential) by July 1977. Based on the initial showings, the potential exists for ten new mining projects, extension of three existing mines, and a commercial in situ coal gasification project by 1990. It should be noted that the in situ gasification process is still in an experimental stage, and that several parties are conducting or will conduct small scale testing of the process. Timing and scale of commercial in situ gasification project will be somewhat dependent on results of this testing. Preference right lease applications are shown on Map 1, Appendix A, and development potential is summarized in Table R8-21.

Additional interest in potential coal development has been expressed through industry proposals on approximately 32,000 acres of coal land. The potential exists for eight new mines and extension of two additional mines. Involved lands are shown on Map 1, Appendix A. Development potential for areas of interest is summarized in Table R8-21.

The high-level scenario presents a cumulative assessment of impacts from new coal development in the region. This new coal development includes the site-specific action (Buckskin) as well as the potential coal development described above.

The high-level scenario also presents a cumulative assessment of potential coal development, the site-specific action, continuation of fourteen mines which are operating or pending approval, coal-related development (one power plant, one gasification plant, and completion of a new major rail line), and other major regional development (oil and gas, uranium, transmission line construction, and municipal development).

Tables R8-22, R8-23, R8-24, and R8-25 define, derive, and summarize acreage and water requirements for the high-level scenario. The assumptions and guidelines used in developing the analysis of the high-level scenario include those in Chapter 1 plus the assumptions which follow. Where data were unavailable, conversion factors were developed for use in the high-level scenario using averages of data used in Chapter 1.

Assumptions

As stated in Chapter 1, Assumptions and Analysis Guidelines.

Companies would mine coal and accomplish reclamation as stated in preliminary proposals and/or initial showings in a manner consistent with state and federal law.

Time frames for potential coal development assume that there will be no new federal coal leasing prior to 1980. Thus the following represents a possible development sequence:

Year 0—Lease issuance.

Year 1—Mining and reclamation plan approval; begin construction.

Year 2—Construction continues.

Year 3—Complete construction; initial production (one half of full production).

Year 4—Full production.

Year 5—Full production continues.

Conversion Factors

Preliminary proposals and initial showings were used to develop figures for potential coal development in the high-level scenario. Where information was lacking, the conversion factors listed below were used. These conversion factors are based on averages of known mining plans and operations in the region.

1. Average acreage disturbed per year per million tons of coal mined equals 35.
2. Average acreage disturbed for rights-of-way and mine facilities equals 200 per coal mine.
3. Average mine life is 30 years.
4. Ninety percent of coal reserves are recoverable by surface mining.
5. Employment: construction—100 employees per mine; operations—30 employees per million tons of annual production.
6. Market calculations in unit trains and direction: east—43%; southeast—57%.

Impact Analysis

The impacts of the high-level scenario are analyzed at two levels: (1) the impacts of new (proposed and potential) coal development in the region, and (2) the cumulative impacts of all development in the region under the high-level scenario. This analysis focuses on impacts which differ significantly from those discussed in Chapter 4; therefore, the reader is directed to that chapter for additional detail on the general character of impacts.

Air Quality

Emissions and Modeling Procedures. The high-level scenario emission sources include, in addition to the low level sources, one proposed mine (the Buckskin Mine), and the potential development of additional mines.

Some of the potential mines provided very little information concerning mining procedures; therefore emissions were calculated using a method described in the Technical Report for Chapter 8, on file at the Bureau of Land Management, Casper District Office. The locations of the additional high-level scenario developments are shown on Figure R8-10. The emissions for each of the mines are listed in Table R8-26. The emissions from urban areas for the high-level scenario are shown in Table R8-27.

Highway traffic is expected to increase in parts of the region by 1990. Increased commuter traffic may increase TSP, NO_2, and carbon monoxide (CO) concentrations along highway corridors for a few hours each day. The traffic, however, is not expected to cause any regional impact on air quality.

TABLE R8-22

CUMULATIVE DEVELOPMENT FOR THE REGION
HIGH LEVEL OF DEVELOPMENT

	1978	1980	1985	1990
Coal Mining				
Number of Coal Mines*	10	20	36	38
Number of In Situ Gasification Projects	0	0	1	1
Coal Mine Support Facilities:				
Miles of Rail Spurs	39	90	164	178
Miles of Telephone Lines	30	55	120	123
Miles of Access Roads	7	30	62	65
Miles of Conveyor System	0	7	13	13
Miles of Power Lines	76	110	157	170
Coal-Related Development				
Number of Power Plants**	2	2	2	2
Number of Gasification Plants	0	0	1***	1
Miles of Railroad Line				
Main Line (common-carrier)	26	113	113	113
Private	0	0	40	40
Uranium				
Cumulative Number of Uranium Mines	3	6	12	12
Cumulative Number of Uranium Mills	2	3	7	7
Cumulative Number of In-Situ Uranium Leaching Projects	0	0	1	1
Oil and Gas				
Area of Activity (acres)	4,800	4,880	5,110	5,250
Other				
Miles of New 230-kv Transmission Lines	0	0	87	87
Population increase(1,000's)****	0	4	28	36

Note: 1978 base, and based on industry plans and indicated trends.

* Counts East Gillette and Kerr McGee #16 individually.
** Wyodak and Dave Johnston.
*** Under construction.
**** Centaur Management Consultants, Inc. 1978. Based on University of Wyoming (1978) projection model for Campbell and Converse counties. Population increases represent increased population over 1978 base population (37,780).

TABLE R8-23

SUMMARY OF CUMULATIVE ACREAGES DISTURBED AND RECLAIMED BY COAL MINING ACTIVITY
HIGH LEVEL OF DEVELOPMENT

		Cumulative Acreage			
		1978	1980	1985	1990
Surface Mine Operations		2,515	5,983	23,384	43,806
Power Lines		451	660	940	1,020
Rail Spurs		859	1,890	3,440	3,740
Access Roads		128	360	740	780
Conveyor Systems		0	70	130	130
Mine Structures		1,039	2,200	3,470	3,750
Relocations		36	190	190	190
Totals:	Acres Disturbed	5,028	11,353	32,294	53,416
	Acres Reclaimed	1,234	3,495	11,687	20,266
	Difference	3,794	7,858	20,607	33,150

TABLE R8-23a

COMPARISON OF CUMULATIVE AGREAGES FOR EXISTING AND
NEW (PROPOSED AND POTENTIAL) COAL MINING ACTIVITY

	1978	1980	1985	1990
Existing Coal Mining Activity*				
Acres Disturbed	5,028	8,119	16,084	22,136
Acres Reclaimed	1,234	3,495	9,887	12,652
Difference	3,794	4,624	6,197	9,484
New Coal Mining Activity**				
Acres Disturbed	0	3,234	16,210	31,280
Acres Reclaimed	0	0	1,800	7,614
Difference	0	3,234	14,410	23,666

* From Table R8-3.
** Calculated by subtracting existing coal mining activity acreages from total acreage difference in the table above (R8-23).

TABLE R8-24

CUMULATIVE ACREAGE DISTURBED AND RECLAIMED BY REGIONAL DEVELOPMENT ACTIVITIES
HIGH LEVEL OF DEVELOPMENT

	1978	1980	1985	1990
Acreage Disturbed				
Coal Mining Activity*				
Existing	5,028	8,119	16,084	22,136
New	0	3,234	16,210	31,280
Power Plants	2,000	2,000	2,000	2,000
Coal Gasification	0	0	1,500	1,500
Railroad Line				
Main Line	546	2,373	2,373	2,373
Private	0	0	840	840
Uranium	5,000	6,200	15,300	21,800
Oil and Gas	4,800	4,880	5,110	5,250
Sand, Gravel, Scoria	200	200	620	1,280
230-kv Transmission Line	0	0	1,566	1,566
Population**	0	559	4,184	5,386
TOTAL	17,574	27,565	65,787	95,411
Acreage Reclaimed				
Coal Mining Activity*				
Existing	1,234	3,495	9,887	12,652
New	0	0	1,800	7,614
Other Activities	400	2,400	6,550	13,300
TOTAL	1,634	5,895	18,237	33,566
Difference	15,940	21,670	47,550	61,845

Note: For average acreage requirements, refer to Table R1-4.
* From Table R8-23a.
** Acreage required for population increase over 1978 base municipal acreage.

TABLE R8-25

INCREASED WATER USAGE FOR THE REGION
HIGH LEVEL OF DEVELOPMENT

Type of Use	Annual Water Requirements (Acre-feet) 1975	1978	Inc.*	1980	Inc.*	1985	Inc.*	1990	Inc.*
Coal Mines	170	980	810	2,500	2,330	5,000	4,830	6,200	6,030
Irrigation	10,000	10,000	0	10,000	0	10,000	0	10,000	0
Municipal**	3,990	7,030	3,040	7,640	3,650	16,530	12,540	18,810	14,820
Oil Fields (water-flood)	12,000	12,000	0	12,000	0	12,000	0	12,000	0
Uranium Mines	80	140	60	230	150	400	320	425	345
Uranium Mill	500	4,200	3,700	6,200	5,700	13,200	12,700	16,200	15,700
In-Situ Leaching Projects	0	0	0	0	0	225	225	225	225
Power Plants***	7,500	7,630	130	7,630	130	7,630	130	7,630	130
Gasification Plants	N/A	N/A	N/A	N/A	N/A	15,000	15,000	19,000	19,000
Stockwater and Domestic	10,000	10,000	0	10,000	0	10,000	0	10,000	0
TOTAL	44,240	51,980	7,740	56,200	11,960	89,985	45,745	100,490	56,250
Sewage**** (Based on 70% of municipal use)	2,800	5,060	2,260	5,290	2,610	11,571	8,771	13,167	10,367

Note: Based on Table R1-7 with projected high-level increases.
* Increase over base year (1975).
** Includes need for projected population increase in the region.
*** Includes Wyodak air-cooled and Dave Johnston water-cooled plants.
**** Not a part of cumulative total.
N/A = Not applicable.

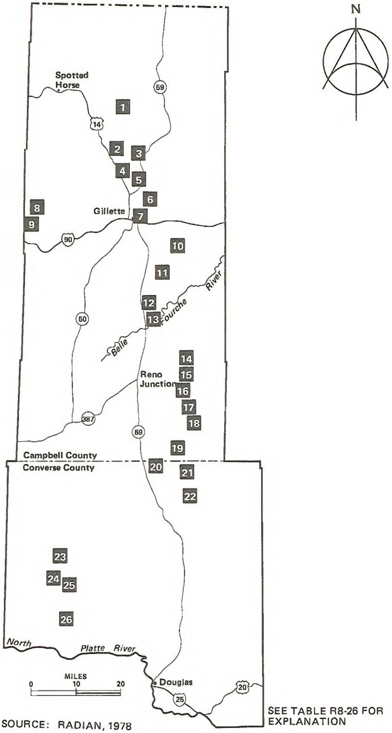


Figure R8-10
LOCATION OF PROPOSED FEDERAL ACTION AND POSSIBLE COAL DEVELOPMENTS

TABLE R8-26

PARTICULATE EMISSIONS (TONS/YEAR) FROM PROPOSED AND POSSIBLE DEVELOPMENTS

Map Number	Description of Activity	1980	1985	1990
1	New surface mine		2,778	1,507
2	New surface mine		6,227	6,227
3	New surface mine		1,137	2,628
4	Site-specific action (Buckskin)	762	1,175	1,275
4a	Possible Extension to 4	762	1,175	1,275
5	New surface mine		157	361
6	New surface mine		931	1,628
7	New surface mine		2,121	3,457
8	New surface mine		4,917	4,917
9	In situ gasification plant			
10	New surface mine		2,066	5,333
11	Possible mine extension		4,289	4,520
12	New surface mine		928	1,628
13	New surface mine**			
14	New surface mine	745	1,190	2,416
15-a	New surface mine		1,624	2,121
15-b	New surface mine		1,146	2,121
15-c	New surface mine		700	2,121
15-d	New surface mine			1,624
15-e	New surface mine			1,146
16	Possible mine extension		2,754	3,149
17	Possible mine extension		4,793	3,744
18	Possible mine extension		4,793	3,744
19	New surface mine		781	752
20	New surface mine		3,862	4,712
21	New surface mine		1,117	2,077
22	New surface mine		507	1,734
23	New surface mine		1,226	3,916
24	New underground mine			266
25	New surface mine		182	256
26	New underground surface mine		923	923

* See Figure R8-10.

** Very small project - production will be minimal.

TABLE R8-27

EMISSIONS OF PARTICULATES, SO_x, AND NO_x FROM TOWNS (TONS/YEAR)
HIGH-LEVEL SCENARIO

Town	Pollutant	1980	1985	1990
Gillette	Particulates	53	70	75
	SO_x	56	74	80
	NO_x	303	401	431
Moorcroft	Particulates	20	33	39
	SO_x	17	28	33
	NO_x	99	165	196
Glenrock	Particulates	22	32	33
	SO_x	17	25	26
	NO_x	117	175	182
Douglas	Particulates	36	61	60
	SO_x	29	49	48
	NO_x	200	334	329
Casper	Particulates	172	178	182
	SO_x	189	196	200
	NO_x	555	573	660

A complete lack of data on the design and operations schedule of the in situ gasification plant precluded any modeling attempt.

The same dispersion modeling procedures used for the probable level analysis in Chapter 4 were used for the high-level scenario.

Proposed and Potential Development Alone. Concentrations referred to in this section are the contributions from the proposed and possible coal developments to pollutant levels. These contributions do not include baseline levels or contributions from other activities. Since most of the fugitive dust generated by mining operations would consist of relatively large diameter particles, most particulate deposition would occur within a few miles of the individual mines.

In 1980, only the site-specific action (Buckskin Mine) and one possible mine (14) (see Figure R8-10) are predicted to be producing coal. Increased TSP concentrations would not exceed 1 $\mu g/m^3$ except at the center of mining activities.

By 1985, possible development would include 26 mines, and by 1990, 29 mines. Figures R8-11 and R8-12 show predicted increases in annual TSP concentrations for 1985 and 1990. The major impact would occur in the area near Gillette. In this area, increases to the annual TSP concentrations would reach 10 $\mu g/m^3$ by 1990. The maximum increase to the 24-hour concentration should be approximately 34 $\mu g/m^3$.

None of the concentrations resulting from the proposed or possible coal development alone would violate the Wyoming TSP standard.

Interactions of the Proposed Coal Development and Other Activites. Concentrations mentioned in this section refer to the total concentrations (including baseline concentrations) due to the entire high-level scenario.

The high level of development would affect air quality over a large area and would cause higher concentrations of pollutants than the low level or probable level of development, except for 1980. In 1980, concentrations would be almost identical to the low-level scenario since additional development for the high-level scenario would be small and would have very little impact. See Figure R8-1 for TSP concentrations in 1980.

In 1985 and 1990, the maximum TSP concentrations would occur in the Gillette area. The interaction of Gillette's emissions with those of mine 7 (see Figure R8-10) would cause annual TSP concentrations of 45 $\mu g/m^3$ in 1985 and of about 65 $\mu g/m^3$ in 1990. Possible development mines would contribute 10 $\mu g/m^3$ to both concentrations. Hence, in 1990, Wyoming's annual standard of 60 $\mu g/m^3$ is predicted to be exceeded in the area where the emissions from Gillette and mine 7 interact. The maximum 24-hour concentration in this area for 1985 and 1990 would be 154 $\mu g/m^3$ and 227 $\mu g/m^3$ respectively. Thus, the Wyoming 24-hour standard, 150 $\mu g/m^3$, would be violated in 1985 and 1990. See Figures R8-13 and R8-14 for TSP concentrations in 1985 and 1990.

With application of the 43 CFR 118 regulations, it is unlikely that the violations discussed above would occur. However, without modeling, it is not possible to say for certain.

Emissions from Gillette and a string of mines north-northwest of the town would interact and cause TSP concentrations of 30 $\mu g/m^3$ within a 2½-mile by 25-mile strip. Southeast of Gillette, interactions between the emissions of existing mines and possible development mine 12 (see Figure R8-10) would cause annual TSP concentrations to rise to 35 $\mu g/m^3$ in the area between the mines.

In Converse County, mines 23 and 26 (see Figure R8-10) would interact with the plume from the Dave Johnston Power Plant. The interactions would be small, raising concentrations 3 to 6 $\mu g/m^3$ above the baseline level of 24 $\mu g/m^3$.

The emissions from mines would not interact with Moorcroft, Douglas, and Glenrock. In addition there would be little change of the TSP concentration in Glenrock for the three study years. Annual average TSP concentrations around Moorcroft and Douglas would increase from 26 $\mu g/m^3$ in 1980 to 30 $\mu g/m^3$ in 1990. The area affected by these changes would be small.

Gillette would experience the largest population growth due to the high-level of development, and as a result, it would be subjected to the highest concentration of gaseous pollutants in the region. Annual SO_2 concentrations of 8 $\mu g/m^3$ in 1980 would increase to 23 $\mu g/m^3$ in 1985 and to 33 $\mu g/m^3$ in 1990. The maximum 24-hour SO_2 concentration is expected to reach 112 $\mu g/m^3$ in Gillette by 1990. The maximum 3-hour concentration in 1990 would be 185 $\mu g/m^3$. These concentrations are below Wyoming and national standards.

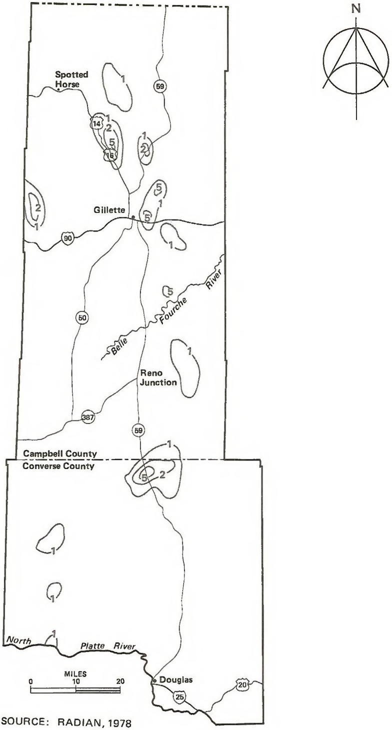
Annual NO_2 concentrations surrounding Gillette would increase from 40 $\mu g/m^3$ in 1980 to 70 $\mu g/m^3$ in 1985 and 90 $\mu g/m^3$ in 1990. It is very likely the state and federal standard of 100 $\mu g/m^3$ could be exceeded in downtown Gillette in 1985 or 1990. In the Gillette area, approximately 30 $\mu g/m^3$ of the NO_2 concentration in 1990 would be due to the proposed federal action and possible coal development.

Annual SO_2 concentrations for Douglas and Glenrock should remain approximately 8 $\mu g/m^3$ during the study period. Annual SO_2 concentrations in Moorcroft would increase from 6 $\mu g/m^3$ in 1985 to 8 $\mu g/m^3$ in 1990.

Annual NO_2 concentrations for Douglas would reach 30 $\mu g/m^3$ in 1985 and 1990. Concentrations of 65 $\mu g/m^3$ may occur in 1990. These concentrations would be below the Wyoming and national standards. NO_2 concentrations would remain low for Glenrock and Moorcroft, at approximately 20 $\mu g/m^3$ for 1985 and 1990.

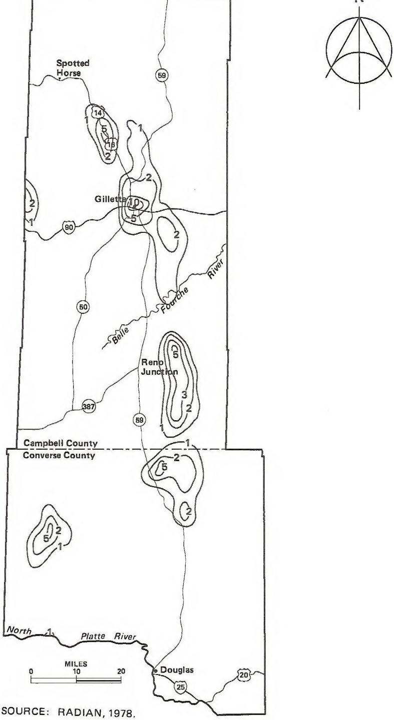
Regional SO_2 concentrations for 1980 would be essentially the same as that shown on Figure R8-4. The remaining SO_2 and NO_2 annual concentrations are shown on Figures R8-15 through R8-19. The maximum short-term concentrations are listed for the towns in Table R8-28.

The horizontal visibility related to TSP concentrations for the region is expected to remain near the baseline of 54 miles. This would be true in most cases beyond 8 miles from the mine boundaries. Between mines which are large enough and close enough to interact, visibilities



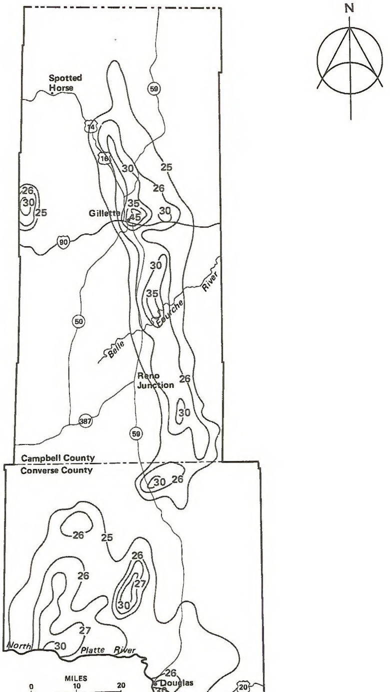
SOURCE: RADIAN, 1978

Figure R8-11
INCREASE OF TSP CONCENTRATIONS (μg/m³) DUE TO THE PROPOSED AND POTENTIAL COAL DEVELOPMENT ALONE FOR 1985



SOURCE: RADIAN, 1978.

Figure R8-12
INCREASE OF TSP CONCENTRATIONS (μg/m^3) DUE TO THE PROPOSED AND POTENTIAL COAL DEVELOPMENT ALONE FOR 1990



SOURCE: RADIAN, 1978

Figure R8-13
ANNUAL TSP CONCENTRATIONS (μg/m^3)
FOR THE HIGH LEVEL SCENARIO FOR 1985

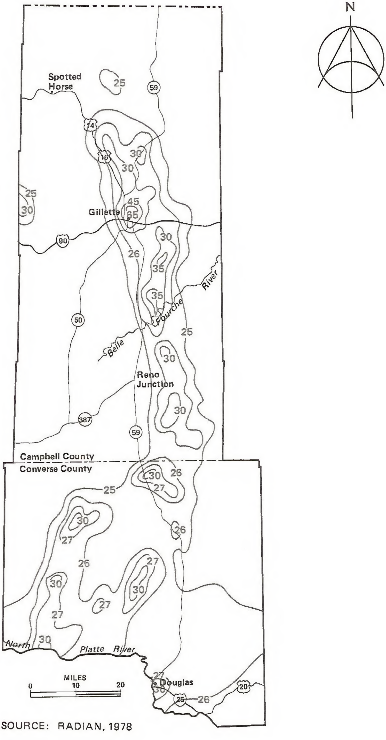
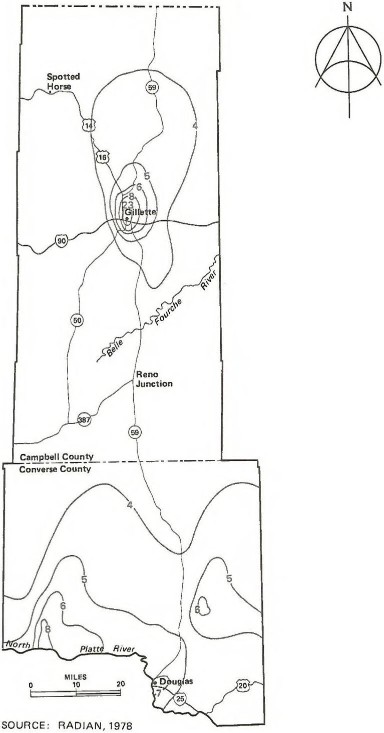
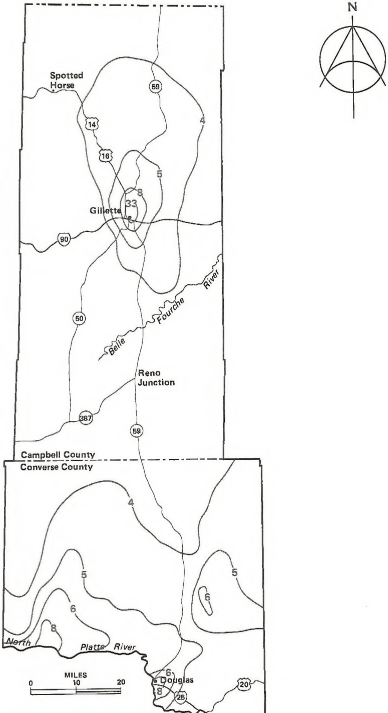


Figure R8-14
ANNUAL TSP CONCENTRATIONS ($\mu g/m^3$)
FOR THE HIGH LEVEL SCENARIO FOR 1990



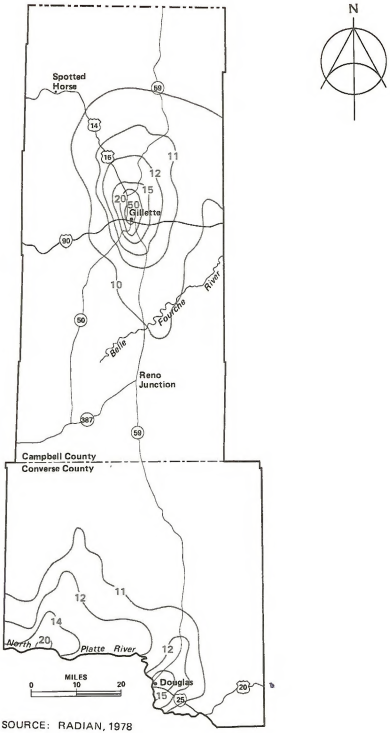
SOURCE: RADIAN, 1978

Figure R8-15
ANNUAL SO_2 CONCENTRATIONS ($\mu g/m^3$) FOR THE HIGH LEVEL SCENARIO FOR 1985



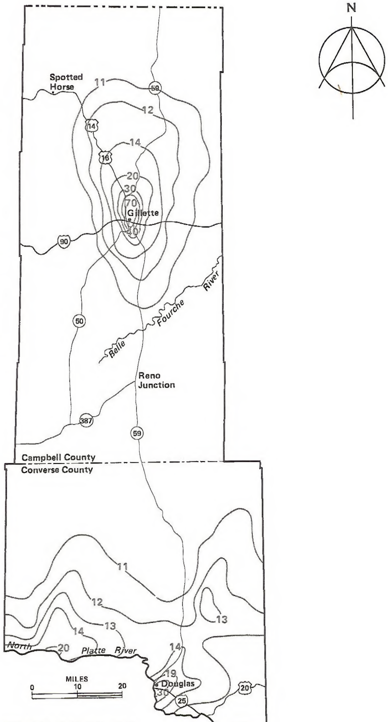
SOURCE: RADIAN, 1978

Figure R8-16
ANNUAL SO_2 CONCENTRATIONS ($\mu g/m^3$)
FOR THE HIGH LEVEL SCENARIO FOR 1990



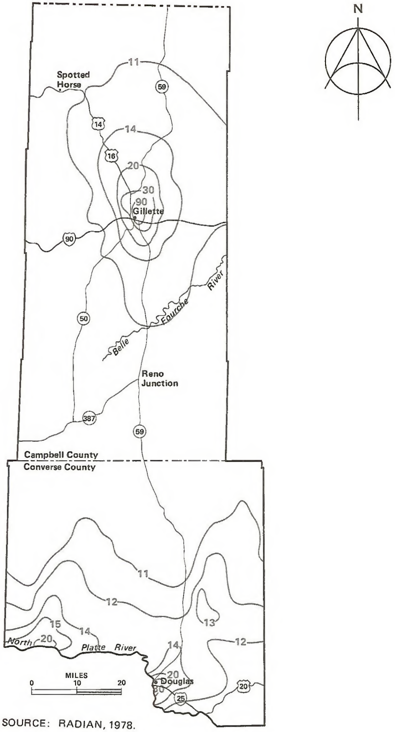
SOURCE: RADIAN, 1978

Figure R8-17
ANNUAL NO_2 CONCENTRATIONS ($\mu g/m^3$)
FOR THE HIGH LEVEL SCENARIO FOR 1980



SOURCE: RADIAN, 1978

Figure R8-18
ANNUAL NO_2 CONCENTRATIONS ($\mu g/m^3$) FOR THE HIGH LEVEL SCENARIO FOR 1985



SOURCE: RADIAN, 1978.

Figure R8-19
ANNUAL NO_2 CONCENTRATIONS ($\mu g/m^3$) FOR THE HIGH LEVEL SCENARIO FOR 1990

TABLE R8-28

ANNUAL AND MAXIMUM SHORT-TERM CONCENTRATIONS ($\mu g/m^3$) PREDICTED AROUND TOWNS IN THE REGION FOR THE HIGH-LEVEL SCENARIO WITH THE NATIONAL AND WYOMING AIR QUALITY STANDARDS ($\mu g/m^3$)

		Averaging				National Standards		Wyoming
Town	Pollutant	Period	1980	1985	1990	Primary	Secondary	Standard
Gillette	TSP	Annual	35	35	65	75	60	60
	TSP	24-hour	119	154	221	260	150	150
	SO_2	Annual	8	23	33	80	-	60
	SO_2	24-hour	27	78	112	365	-	260
	SO_2	3-hour	45	129	185	-	1,300	1,300
Moorcroft	TSP	Annual	26	26	30			
	TSP	24-hour	88	88	102			
	SO_2	Annual	4	6	8			
	SO_2	24-hour	14	20	27			
	SO_2	3-hour	22	34	45			
Douglas	TSP	Annual	26	30	30			
	TSP	24-hour	88	88	102			
	SO_2	Annual	5	7	8			
	SO_2	24-hour	17	24	27			
	SO_2	3-hour	28	39	45			
Glenrock	TSP	Annual	27	30	30			
	TSP	24-hour	92	102	102			
	SO_2	Annual	8	8	8			
	SO_2	24-hour	27	27	27			
	SO_2	3-hour	45	45	45			

Note: Standards for averaging times less than one year are not to be exceeded more than once a year.

would be reduced to 44 miles. The 24-hour visibilities would be reduced to 17 miles where these interactions occur. Annual visibility near Gillette would be reduced from 40 miles in 1980 to 28 miles in 1990. In 1990, 24-hour visibilities may be as low as 10 miles in the Gillette area.

The Chapter 8 Technical Report, on file at the Casper District Office of the Bureau of Land Management, contains additional TSP, SO_2, and NO_2 analyses of the high-level scenario discussed above.

Topography

Under the high-level scenario, topography would be altered by mining in the following amounts for the time frames indicated.

1980—5,983 acres (.12% of the region) at 20 mine sites or 1,271 acres more than at the low level.

1985—23,384 acres (.47% of the region) at 36 mine sites or 10,707 acres more than at the low level.

1990—43,806 acres (.88% of the region) at 38 mine sites or 25,077 acres more than at the low level.

Of the above acres, the following amounts would be reclaimed to a more gentle, smoother surface generally 10 to 40 feet lower than now exists.

1980—3,495 acres (.07% of the region) or the same as at the low level.

1985—11,687 acres (.23% of the region) or 1,800 acres more than at the low level.

1990—20,266 acres (.41% of the region) or 7,614 acres more than at the low level.

The following area would remain in pit and spoil pile topography.

1980—2,488 acres (.05% of the region) or 1,271 acres more than at the low level.

1985—11,697 acres (.23% of the region) or 8,907 acres more than at the low level.

1990—23,540 acres (.47% of the region) or 17,463 acres more than at the low level.

Topography would be altered at uranium mines and quarry sites (sand, gravel, and scoria). Acreages disturbed and reclaimed by these acvities are discussed in Chapter 4 and would not change under the high-level scenario.

Oil and gas activities cause only slight alteration of the topography. Areas thus disturbed and reclaimed are also discussed in Chapter 4 and would not change under the high-level scenario.

Topography would be changed only slightly by coal-related development at mine support facility sites (an average of 200 acres per mine). The main impact of these activities would be at cut and fill sites to maintain grade along access roads and railroads. Acres disturbed by roads and railroads under the high-level scenario would be 4,623 acres in 1980 (867 more than at the low level); 7,393 acres in 1985 (2,797 more than at the low level); and 7,733 acres in 1990 (3,137 more than at the low level).

Disturbance would occur along 233 miles of access roads and railroads by 1980 (46 miles more than at the low level), along 379 miles by 1985 (152 more than the low level), and along 396 miles by 1990 (169 more than the low level).

Figures for total area disturbed by all regional development may be found in Table R8-24 for the high-level scenario.

Geology

Under the high-level scenario, loss of geologic record would be about 18,605,145 acre-feet at coal mines, or about double the low level of 10,683,445 acre-feet and the probable level of 10,766,170 acre-feet. The beneficial impact of exposure of otherwise inaccessible geologic data to scientific examination would be approximately doubled.

Paleontology. Under the high-level scenario, the potential fossil-bearing strata lost by 1990 would be nearly twice that lost under the low and probable levels. The beneficial impact of exposure of fossil material for scientific examination would also be nearly doubled.

Soils

Future population increases in the region would result in the removal of soil from several thousand acres by the year 1990 (see Table R8-24). This permanent loss of soil surface would result from the construction of housing and support facilities. Also, an increase in population would result in greater use of the region's soils for recreation, particularly off-road vehicle use. The amount of impact on soils that would result from recreation is unknown.

Major disturbance and alteration of soils as a result of mining would cause a reduction in soil productivity on the affected soils. Chapter 4 describes the various processes resulting in loss of soil productivity.

For a summary of cumulative acreages disturbed and reclaimed by new coal mining activity under the high level of development, refer to Table R8-23.

For a summary of cumulative acreages disturbed and reclaimed by all regional development activities under the high level of development, refer to Table R8-24.

Water Resources

Groundwater. The difference in impacts between the high and low level of development is a difference in scale rather than type of impacts. The impacts of additional mining of the Wyodak seam, or its northern equivalents in the region, would be the same as those previously described for the low and probable levels. The impact of a particular mine would depend on whether the mine is located in a recharge or discharge area and on the coal to overburden ratio.

If the coal that crops out along the breaks of the Powder River is mined in the future, the impact on groundwater in the coal, if the coal is saturated, would be similar to that which would occur north of Gillette at existing mines.

If new coal mines open on the west side of the Powder River structural basin in the southern part of the region, unlike the situation at the Dave Johnston Mine, saturated overburden and/or coal may be disturbed. Because the sandstone in the area is apparently more permeable than that to the north, the impacts, other than those on quality of water, would be similar to impacts of surface uranium mines in the area. Aside from radioactive material that may be present, the impact on quality of water would be the same as described for mines on the Wyodak seam.

The in situ gasification of coal is projected under the high level of development. While some water is required for the production of a high-quality gas, large quantities of water are detrimental to the in situ gasification process. If a coal is saturated, dewatering would be necessary with concomitant lowering of water levels in the adjoining coal. Toxic substances, phenols and cyanides, do enter the groundwater system by convective transport in both the vapor and solution phases of in situ gasification. Although toxic substances have been demonstrated to enter the groundwater, experiments in the field and laboratory by Lawrence Livermore Laboratories indicate that concentrations of toxic material return to the levels existing before gasification in a matter of months only 300 feet from the gasification site (personal communication, Geological Survey, Water Resources Division, Cheyenne 1978). This rapid decrease in toxic material is attributed to the sorptive properties of the coal.

Impacts of additional uranium mining, uranium mills, and coal gasification plants would be the same type as for the probable level. Table R8-25 shows projected water use under the high level of development. Increased use would probably be from groundwater.

Surface Water. The high level of mining activity in the region envisions a coal production about 110% greater than that of the most probable level. This would result in an almost continuous, crescent-shaped area of impact about 120 miles long stretching from just north of Glenrock, up through a point about 10 miles east of Reno Junction, to a point about 30 miles north of Gillette.

Some major impacts to the surface water resource are estimated in Table R8-29. Depressions and potholes caused by differential settlement in the reclaimed areas would increase infiltration and probably be beneficial on a short-term basis. On a long-term basis however, each depression could become a collector of water-transported, toxic materials which have leached from the reclaimed spoils. This could be especially true if the depression should contact the groundwater table.

Settlement of the area where larger streams traverse the reclaimed spoils would cause interception of the drainage upstream from the mine. Entrapment of streamflow from this drainage would depend on the areal extent and depth of settlement. Flow entering the depression would cause downcutting of the unmined stream bed, downcutting and headcutting of tributaries, and increased sedimentation for a distance upstream from the mine. This would depend upon the amount of settlement. Flow entirely trapped in the depression would lose its sediment load; but that which overflows the depression would cause erosion and downcutting of the unmined channel downstream from the mine, with the same impacts just described for the stream portion entering the mine. This impact would probably be insignificant until after final reclamation since major streams are usually routed around the mine during mining.

Point-watering sources in the form of streamflow, ponds scattered intermittently through nonflowing stream beds, watering tanks supplied by wells, and stock ponds would be destroyed at the rate mining progresses.

Estimated potential sedimentation in Table R8-29 is that which could conceivably occur from spoil piles and other unreclaimed mine areas during years of heavy rainstorm activity. Much of this sediment would be trapped on the mine site but some would escape and add to the natural sediment stream load carried on downstream away from the mines. This impact should be eliminated with completion of reclamation.

See Table R8-25 for a tabulation of estimated water use in the region. Water use by all coal mining by 1990 is estimated to be about 3½% of all of the surface flow originating in the region (about 184,000 acre-feet per year), and to be about 13% of the total water currently used in the region (about 49,520 acre-feet per year).

The ash waste from the coal gasification plants and the finely ground wastes from the uranium mills would probably be a long-term source of water contamination by salts and heavy metals. The potentially most hazardous contamination may be the radioactivity escaping from the abandoned, covered tailings piles of uranium mills. These contain about 85% of the total radiation activity within the uranium ore being processed, which amounts to about 1,800 microcuries per pound (Clark and Kerr 1974). The main radioactive products emanating from the wastes include radon-222 gas escaping into the atmosphere and radium-226 (half-life 1,620 years) possibly escaping via water leaching into the ground and then out again in the form of seeps and springs, or via water traveling over the land after seeping from the piles. Radiation from radium-226 attacks the bones in animals. The maximum allowable concentration of radium-226 in water exposed to humans is about 3 picocuries per liter (pc/l). A range from 0.5 to 65 pc/l was found from about 60 samples from five effluents from uranium mines in the Colorado River Basin (Clark and Kerr 1974). Data are insufficient to quantify an estimated high level of impact for coal gasification and uranium industries.

See Chapter 4 for contrast of impacts and for discussion of possible degradation of water quality due to coal mining. This impact is expected to slowly decrease over a long period of time after mining is completed, until the impact is negligible. Data are insufficient to estimate this period of time.

Vegetation

Terrestrial. All coal development (existing, proposed, and potential) in the region would result in the removal of native vegetation and loss of productivity for varying periods of time on an estimated 11,353, 32,294, and 53,416 acres by 1980, 1985, and 1990 respectively. Ap-

TABLE R8-29

IMPACTS OF HIGH LEVEL OF DEVELOPMENT ON SURFACE WATER RESOURCES

	VALUES AT HIGH LEVEL OF ACTIVITY*		VALUES AT PROBABLE LEVEL OF ACTIVITY*	
	1990	Long Term**	1990	Long Term**
Impacts***	All Activity	All Activity	All Activity	All Activity
Estimated depressions in square miles (40%, ± 10% will probably be fed by groundwater).	3.6 to 5.3	50 to 80****	2.5 to 3.6	9½ to 13
Estimated potential intercepted drainage area in square miles.	(None until end of final reclamation)	Up to 3,000	--	620 to 2,000
Estimated lost point-water sources:				
Ponds in acres (includes flowing wells, springs, playas, and lakes).	520	2,700	330	440
Wet streams in miles (perennial sections and wet-pothole sections).	78	400	50	80
Estimated potential sedimentation in acre-feet per year.	570	--	340	--

* Includes all mines, plants, and everything connected with them.

** After mining and reclamation is done.

*** The greatest impact in the region may occur to the quality of the water. There is not enough data available to quantify this degradation; see text for qualitative analysis.

**** Estimated water loss due to evaporation = 16,600 acre-feet/year or 23 cubic feet per second.

proximately 1.0% of the region's surface acreage would be disturbed by coal activity by 1990. Additional disturbance of native vegetation would occur due to increased outdoor recreation (particularly off-road vehicle travel). Disturbed coal lands would be reclaimed by an estimated rate of 3,495 acres by 1980, 11,687 acres by 1985, and 20,266 acres by 1990. (Approximately 41% of the lands disturbed by coal activity by 1990 would be reclaimed.)

Total surface disturbance in the region resulting from coal-related and all other mineral activities would result in the removal of native vegetation on an estimated 27,565, 65,787, and 95,411 acres by 1980, 1985, and 1990. (Figures do not include outdoor recreation disturbances due to lack of data.) Coal mining would constitute about 41% (11,353 of 27,565 acres), 49% (32,294 of 65,787 acres), and 56% (53,416 of 95,411 acres) of the regional surface disturbance by 1980, 1985, and 1990 respectively.

Reclamation would be conducted generally on an ongoing basis. On a total disturbance basis, it is estimated that 5,895, 18,237, and 33,566 acres would be reclaimed by 1980, 1985, and 1990 respectively.

The removal of native vegetation and losses of vegetative production would affect numerous living and nonliving components of the environment. (See Chapter 4, Vegetation, and Chapter 8, Low-Level Scenario for reclamation problems and predictions of success). Under the high-level scenario, the impacts would increase by a factor of 56% over the low-level scenario and occur over a larger area.

Aquatic. Under the high-level scenario, the impacts to aquatic vegetation in ponds and streams would increase by a factor of five over the low-level scenario (see Table R8-29).

Endangered and/or Threatened Species. There is no record of any endangered or threatened plant species in the region; therefore no impact would be anticipated (see Chapter 2).

Fish and Wildlife

The combination of existing, proposed, and potential coal and other development would represent an increase in wildlife habitat destruction of about 10% in 1980, 33% in 1985, and 49% in 1990, when compared to the low-level scenario. Table R8-30 shows projected losses by habitat type under the high-level scenario. Under this scenario, there would be almost 96.6 square miles of habitat unreclaimed by 1990. Losses to fish and wildlife populations would be at least proportional to the increased loss in habitat. The increase in fires, fences, traffic, noise, and human activity would affect even larger areas of habitat.

Fish. If ground disturbance increases in the Cheyenne, Belle Fourche, and Little Powder River drainages, increased siltation, sewage, and possibly heavy metal concentration, would have serious adverse effects on fish, their aquatic habitat, and all other components of the aquatic ecosystem. The degradation of water quality and increased demand for fishing could overtax the capacity of Keyhole Reservoir to support the fishing pressure.

Terrestrial Wildlife. Under the high-level scenario, a strip of mines would run from the Campbell-Converse County line to nearly 20 miles north of Gillette. These mines, with their associated roads, powerlines, fences, and railroad spurs, would effectively bisect the pronghorn range in Campbell County. The development of coal and uranium in western Converse County would nearly bisect the ranges of pronghorn in this county. Poaching, road kills, and train kills would increase as the regional human population increases.

The development of preference right coal leases along the Campbell-Johnson County line, in the Fortification Creek area, would endanger elk habitat currently considered to be critical winter habitat. Increased human activity in this area would be adverse to the elk in the Fortification Creek herd.

The large losses of small nongame mammals and birds, and reptiles and amphibians would decrease the prey base for raptors and mammalian predators.

Endangered and/or Threatened Species. The habitat for endangered species could be affected by the development of existing undeveloped leases and preference right lease application areas. A comparison of Map 1 and Map 7 in Appendix A shows that a number of prairie dog towns exist on or near areas currently leased or under preference right lease application. Any discovery of black-footed ferrets in these areas would necessitate consultation with the U.S. Fish and Wildlife Service by agencies having authority to approve mining plans in these areas. This consultation is required under Section 7 of the Endangered Species Act.

Habitat disturbance along Antelope Creek and Porcupine Creek could adversely affect bald eagles wintering in these areas. Consultation with U.S. Fish and Wildlife Service would be required by law before any federal action could be taken to approve development in these areas.

Cultural Resources

By 1990, cultural resource sites on an additional 31,000 acres would be threatened with destruction or alteration by new (proposed and potential) coal mining activity. Some may be threatened by their proximity to surface-disturbing activities. The significance of currently uninventoried cultural sites within unsurveyed tracts or buried sites anywhere on the mine sites cannot be determined at this time. Cultural resource inventories required before leasing or subsequent surface disturbance would reduce impacts to these resources.

Other activities affecting cultural resources in the region include uranium mining, coal conversion (power and gasification plants), oil and gas development, railroad, road, and utility construction, off-road vehicle use, vandalism, and private land development. The number of sites which may be disturbed or destroyed by these activities cannot be quantified at this time; however, compliance with Executive Order 11593 and Section 2(b) of the Historic Preservation Act would ensure mitigation of impacts to cultural resources which may be affected by much of the development activity.

TABLE R8-30

SUMMARY OF ADVERSE IMPACTS TO WILDLIFE
HIGH-LEVEL SCENARIO

	1980	1985	1990
Habitat Loss			
Grassland*	697	1,408	2,094
Sagebrush-Grass**	25,353	60,976	88,390
Ponderosa Pine	96	193	289
Riparian	499	1,042	1,532
Greasewood-Saltbush	211	425	623
Aquatic	0	94	109
Cropland	709	1,649	2,374
TOTAL	27,565	65,787	95,411
Population and Progeny Loss			
Birds			
Nongame	125,145	500,625	1,023,885
Raptors	145	490	915
Game			
Waterfowl	0	4,205	6,290
Turkey	0	15	25
Sharp-tailed Grouse	995	3,735	7,345
Sage Grouse	1,860	6,940	13,640
Hungarian Partridge	180	730	1,625
Mourning Dove	3,250	13,340	27,475
Mammals			
Nongame	1,043,760	5,124,770	11,151,920
Furbearers/Predators			
Beaver	110	340	640
Muskrat	0	1,765	2,885
Mink	40	120	230
Coyote	145	610	1,230
Bobcat	5	20	45
Small Game			
Desert Cottontail	6,110	26,960	56,815
Snowshoe Hare	275	1,070	2,290
Big Game			
Pronghorn	220	755	1,425
Mule Deer	125	460	880
White-tailed Deer	1	1	4

* Figures include playa grassland, scoria grassland, and sandhills grassland.
** Figures include sagebrush-grass and silver sagebrush habitat types.

tion, compared with the low-level requirement for 11 officers. Under either scenarios, the department would require 1 additional patrol car by 1990. The high-level population should not affect the fire department's requirement for an additional 500-gallon-per-minute pumper truck and 60 additional volunteer firemen.

In order to provide adequate water supplies for the projected 1990 high-level population, Newcastle would require a peak water supply capacity of 4.9 mgd (compared with a currently planned capacity of 4.4 mgd, and a low-level requirement of 4.7 mgd). Under the high-level scenario, Newcastle's lagoon sewage treatment facility would have to be supplanted by a facility capable of processing 960,000 gpd, compared with the low-level requirement of 900,000 gpd by 1990.

Housing. Table R8-37 shows the projected growth of housing demand in regional communities under the high-level scenario, compared with historical growth rates in the local housing stock. Communities which would experience significant incremental housing impacts under the high-level scenario compared with the low level are Gillette, Douglas, and Glenrock. In Gillette, total housing demand would be expected to increase at an average annual rate of 7.6% under the high-level scenario, compared with 5.5% annually under the low level. Local demand for single-family housing, which would increase at an average rate of 6.0% under the low level, would be expected to grow by 10.4% annually under the high-level scenario. In Douglas and Glenrock, total housing demand under the high level is projected to grow at average annual rates of 8.5% and 8.1% respectively, compared with projected low-level growth rates of 6.5% and 7.6%. However, like Gillette, Douglas and Glenrock would experience considerably higher incremental annual growth rates in demand for single-family housing: 7.7% (high level) versus 3.6% (low level) in Douglas; and 8.5% versus 4.3% in Glenrock. The relatively rapid growth in demand for single-family housing would be to the large percentage of highly paid mining and construction workers among the new arrivals in these communities.

Based on the historical rate of growth in single-family housing in Douglas (comparable data for Glenrock are not available), the housing markets in Douglas and Glenrock would appear capable of meeting projected high-level demand. However, in Gillette, the stock of single-family housing would have to increase at twice its historical rate of growth in order to meet the demand of those desiring and able to afford single-family housing.

Under the low-level scenario, it was estimated that between 60% and 70% of the households in Gillette, Douglas, and Glenrock desiring single-family housing could afford it. Under the high-level scenario, this percentage should increase slightly due to the higher representation of highly paid mining and construction workers.

Education. Table R8-38 depicts projected school enrollment increases under the high-level scenario. The following paragraphs discuss the implication of these projected increases for individual school districts, particularly in comparison with the projected low-level population increases.

According to projections in Table R8-38, the Gillette School District would experience the greatest absolute and relative enrollment increase under the high-level scenario: 1,822 additional pupils, or 28% above the projected low level by 1990. Such an increase would have major implications for the district's building program. While current facilities and planned expansions could accommodate the projected high-level enrollment through the 1984/85 school year, between 1985 and 1990 space would have to be made available for an additional 1,505 pupils (compared with none under the low level). To maintain current pupil/teacher ratios, the school district would also have to hire an additional 281 teachers between 1978 and 1990 under the high level, versus 145 under the low level.

The Douglas School District would also experience significant additional impacts under the high-level scenario. By 1985, the year of peak enrollment, the incremental enrollment attributable to the high level would be 541, or 15% above low-level projections. To accommodate this increase, the district would have to provide an additional 1,547 pupil spaces (compared with 1,006 under the low level). One option open to the school district under the low level would be the use of temporary (mobile and modular) classrooms to get over the 1985 enrollment "hump"without long-term excess capacity. Under the high-level scenario, the post-1985 enrollment decline would be smaller than under the low level (107 versus 324). This means that not only are the short-term space requirements greater under the high-level, but also a larger percentage of the short-term increase should be accommodated in permanent rather than temporary quarters. Under the high-level scenario, the district would also need to hire some 130 additional teachers by 1985, of which 125 would be long-term appointments beyond 1985. The corresponding figures under the low level would be 105 and 80 teachers respectively.

The Casper School District would also have to step up its already active building program if it is to accommodate the 17,923 pupils projected by 1990 under the high-level scenario (compared with 17,310 under the low level). Projected high-level enrollment increases would require an additional 1,500 pupil spaces by 1990 over and above currently planned expansion, compared with 800 more spaces under the low level. To maintain current pupil/teacher ratios under the high level, the district would also need to hire 185 additional teachers by 1990 (compared with approximately 160 under the low level).

Projected incremental impacts of the high-level scenario on other school districts in the eight-county region would be less significant when compared with the low level. Additional space requirements beyond those required under the low level, if any, could be satisfied through expansion of existing buildings and the use of temporary classrooms rather than by the construction of new buildings. Incremental teacher requirements would also be correspondingly smaller.

Health Care. Table R8-39 projects the number of additional physicians, dentists, and nurses needed under the

TABLE R8-37

PROJECTED HOUSING DEMAND
1978-1990
HIGH-LEVEL SCENARIO

Community/ Housing Type	1977 Housing Stock	Average Annual Growth Rate of Housing Stock, 1970-77*	Demand for Additional Housing Units Beyond Current Stock: 1978-1990 Total No. of Units	Demand for Additional Housing Units Beyond Current Stock: Average Annual Growth of Housing Stock Required, 1978-90*
Gillette**				
Single Family	1,623	5.2%	4,223	10.4%
Multi-Unit	680	6.3%	597	5.0%
Mobile	1,542	13.3%	1,331	4.9%
Total all types	3,845	8.1%	6,151	7.6%
Douglas				
Single Family	1,232	6.5%	1,999	7.7%
Multi-Unit	207	0.7%	399	8.6%
Mobile	349	24.8%	973	10.8%
Total all types	1,788	8.2%	3,371	8.5%
Glenrock				
Single Family	439	NA	822	8.5%
Multi-Unit	63	NA	120	8.6%
Mobile	159	NA	212	6.7%
Total all types	661	3.7%	1,154	8.1%
Moorcroft				
Single Family	147	NA	364	10.0%
Multi-Unit	0	NA	79	0
Mobile	150	NA	269	8.2%
Total all types	297	NA	712	9.9%

TABLE R8-37
(cont'd)
PROJECTED HOUSING DEMAND
1978-1990
HIGH-LEVEL SCENARIO

Community/ Housing Type	1977 Housing Stock	Average Annual Growth Rate of Housing Stock 1970-77*	Demand for Additional Housing Units Beyond Current Stock: 1978-1990 Total No. of Units	Demand for Additional Housing Units Beyond Current Stock: Average Annual Growth of Housing Stock Required 1978-90*
Buffalo				
Single-family	1,398	4.8%	73	0.4%
Multi-unit	93	-12.0%	56	3.2%
Mobile	130	11.4%	217	7.8%
Total all types	1,621	3.3%	346	1.5%
Casper				
Single-family	12,034	2.3%	863	0.5%
Multi-unit	3,580	3.0%	453	0.9%
Mobile	655	18.1%	1,454	9.4%
Total all types	16,269	2.8%	2,770	1.2%
Lusk				
Single-family	NA	NA	17	NA
Multi-unit	NA	NA	22	NA
Mobile	NA	NA	93	NA
Total all types	720	0.2%	132	1.3%
Sheridan				
Single-family	3,993	2.1%	633	1.2%
Multi-unit	477	-3.0%	514	5.8%
Mobile	780	45.7%	2,165	10.8%
Total all types	5,250	2.4%	3,312	3.8%
Newcastle				
Single-family	950	0.4%	424	2.9%
Multi-unit	246	6.1%	79	2.2%
Mobile	172	9.9%	258	7.3%
Total all types	1,368	1.6%	761	3.2%

Note: See Table R4-24 for methodology used in making these projections.

* Compounded annually

** 1977 figures for Gillette do not include housing located outside city limits, since comparable data for 1970 are not available. Consequently, average growth in housing stock 1970-1977 is probably understated.

NA = Not available

TABLE R8-38

PROJECTED SCHOOL DISTRICT ENROLLMENTS
1980-1990
HIGH-LEVEL SCENARIO

	1980				1985				1990			
	Elem.	J. H.	H. S.	Total	Elem.	J. H.	H. S.	Total	Elem.	J. H.	H. S.	Total
Campbell												
Gillette	2,832	1,133	850	4,815	4,155	1,662	1,247	7,064	4,956	1,983	1,487	8,426
Converse												
Douglas	1,312	469	375	2,156	2,572	919	734	4,225	2,507	896	715	4,118
Glenrock	481	222	185	888	733	338	281	1,352	712	330	274	1,316
Crook												
Sundance	714	359	334	1,408	874	439	410	1,723	963	484	452	1,899
Johnson												
Buffalo	763	334	324	1,420	812	355	345	1,512	862	377	366	1,605
Natrona												
Casper	7,272	3,298	3,523	14,093	8,261	3,747	4,003	16,011	9,247	4,195	4,481	17,923
Niobrara												
Lusk	304	155	161	621	313	160	166	641	323	165	172	660
Sheridan												
Ranchester	361	188	189	738	362	189	189	740	361	191	189	742
Sheridan	2,009	961	872	3,842	2,619	1,252	1,137	5,008	3,261	1,559	1,416	6,236
Clearmont	89	21	34	144	89	22	34	145	89	22	35	146
Weston												
Newcastle	713	324	353	1,390	808	367	400	1,575	878	399	435	1,712
Upton	245	107	106	458	278	123	118	519	302	133	130	565

Source: University of Wyoming 1978.

TABLE R8-39

PROJECTED HEALTH CARE PERSONNEL REQUIREMENTS
HIGH-LEVEL SCENARIO

	1977 Physicians	Physicians Recommended Levels*			1977 Registered Nurses	Registered Nurses Recommended Level**			1977 Dentists	Dentists Recommended Level***		
		1980	1985	1990		1980	1985	1990		1980	1985	1990
Campbell	9	28	42	50	53	99	146	174	4	18	26	31
Converse	6	13	24	24	29	46	84	83	2	8	15	15
Crook	2	5	7	7	11	19	23	26	1	3	4	5
Johnson	4	7	7	8	30	24	26	27	2	4	5	5
Natrona	80	75	85	95	383	263	299	335	34	47	53	60
Niobrara	2	3	3	3	12	11	11	11	1	2	2	2
Sheridan	26	24	28	33	154	83	99	115	16	15	18	21
Weston	3	7	8	9	26	26	30	32	2	5	5	6
Region	132	163	204	229	698	572	717	804	62	102	128	143

Source: Wyoming Department of Health and Social Services 1977; personal communication, Larry Bertilson, State Health Planning Manager 1978.

* Based on recommended standard of 1,000 persons per physician.
** Based on recommended standard of 285 persons per registered nurse.
*** Based on recommended standard of 1,600 persons per dentist.

high-level scenario to provide adequate levels of health care to the local population through 1990. According to the table, the region would need 97 more doctors by 1990 (versus 78 under the low level) and 81 more dentists (versus 69 under the low level). In addition, the eight-county region would need to recruit 106 additional registered nurses under the high level (compared with 38 under the low level).

The need for additional health care specialists to meet high-level requirements would be particularly acute in Campbell, Converse, Crook, and Weston counties. Campbell County would have to recruit 41 additional physicians (compared with 30 under the low level), 27 dentists (versus 21 under the low level), and 121 nurses (compared with 86 under the low level). In Converse County, the high-level requirements compared with low-level requirements (in parentheses) would be 18 more doctors (14), 13 additional dentists (10), and 54 more nurses (41).

Hospital bed needs, in contrast to health care manpower, are addressed on an eight-county basis. Taking into account the capacity of existing hospital facilities, those under construction, and those planned for the future, the eight-county region would face a deficit of 254 beds by 1990 (compared with 183 under the low level), unless it can improve average bed utilization factors.

Retail Trade. It is assumed that future per capita retail expenditures in the eight-county region, measured in constant 1975 dollars, would continue to grow at the historical rate of 0.7% annually through 1990 (see Chapter 2). On this basis, total 1990 retail sales in the region are projected at approximately $830 million (1975 dollars) under the high-level scenario, a 119% increase since 1975.

It is expected that Natrona County (i.e., Casper) would continue as the region's main trade center through 1990. Natrona County captured more than 50% of all new retail trade in the region between 1972 and 1977. However, the growth of other secondary trade centers (particularly in neighboring Converse County, which should experience rapid population increases in the next decade), would be expected to reduce Natrona County's relative attractiveness as a trade center. In view of this, total 1990 retail sales in Natrona County are estimated at $350 million (1975 dollars), or approximately 42% of total regional sales.

Campbell County (Gillette) and Sheridan County (city of Sheridan) in recent years have emerged as secondary trade centers in their own right. Between 1972 and 1977, both enjoyed shares in regional sales approximately proportional to their respective percentages of regional population. On a similar basis, 1990 retail sales in Campbell County are estimated at $182 million (1975 dollars), and in Sheridan County at $116 million (1975 dollars).

Due to its large increase in population, Converse County by the mid-1980s might also attain the status of a secondary trade center, able to supply the greater part of its residents' retail needs and attracting shoppers from neighboring counties. As such, Converse County might experience annual retail sales up to $83 million (1975 dollars) by 1990, concentrated in Douglas and, to a lesser extent, Glenrock.

Local Finances. As is the case under the low level, the incremental effects of the high-level population growth on local communities' operating and capital balances would vary. The large property tax base at their disposal should enable the county governments and school districts to meet the service and educational requirements of the projected high-level population through 1990.

Municipalities would vary in their ability to cope with the fiscal demands of population growth. Most municipalities, including Gillette, appear able to finance their operating expenditures through 1990, assuming a continuation of state and federal transfers at approximately current levels. However, Douglas, Glenrock, and Moorcroft would all face significant operating shortfalls in the 1980s unless new sources of local or outside funding can be secured. In the case of Douglas, the potential shortfall would be expected to exceed $1.2 million per year (compared to over $1 million under the low level) by 1985. Glenrock and Moorcroft would face smaller, but still significant annual shortfalls of $60,000 and $30,000 respectively (compared with $50,000 and $25,000 respectively under the low level) by the late 1980s. The opportunities for Douglas and Glenrock to raise additional local revenues by levying additional taxes would be rather limited, since Converse County already levies the optional 4% sales tax, and neither can increase its general purpose property tax levies much further. Addition of the 4% optional sales tax in Crook County would help redress Moorcroft's prospective operating shortfall. Otherwise, these communities would have to either turn to the state or federal governments for financial assistance, or cut back on service levels, in order to avoid chronic operating deficits.

The additional population growth foreseen under the high-level scenario would also affect some local communities' capital requirements. In general, the high-level population growth would increase the needed service capacity of the facilities which these communities must provide, rather than requiring new types of facilities. As a result, Gillette's anticipated capital deficit would rise from a low-level figure of $12 million to $13 million, depending on the cost of securing additional water supplies. Other communities' capital requirements under the high-level scenario (mainly for additional water supplies and sewage treatment facilities) would be as follows: Douglas—$6 million (compared with the low-level needs of $5 million); Moorcroft—$1 million (versus $500,000 under the low level); Casper—$6.1 million (compared with $5.5 million under the low level); and Sheridan—$800,000 (only minor expenditures under the low level). With the exception of Sheridan, these expenditures would be beyond local financing capabilities through either current revenues or bonded debt. Possible outside sources of financial assistance include state coal severance tax funds, the U.S. Farmers' Home Administration, or Environmental Protection Agency, as well as the private coal companies.

TABLE R8-40

COMPARISON TABLE OF IMPACTS
(Partial Listing)

		Regional Cumulative			Cumulative No Action Alternative Low-Level Scenario			Cumulative High-Level Scenario		
	Units	1980	1985	1990	1980	1985	1990	1980	1985	1990
Air Quality-Estimated total particulate emissions from major man-made sources	Tons/year	60,422	72,716	77,104	59,660	71,541	75,739	61,470	107,610	131,274
Paleontology-loss of fossils due to collecting and mining	Acre-feet	2,669,324	6,739,226	10,766,170	2,666,495	6,681,968	10,683,445	3,032,150	>11,750,000	>18,500,000
Topography-surface disturbed (total)	Acres	24,593	48,571	62,645	24,191	47,933	61,887	27,565	65,787	95,411
Soil-reduced productivity	Acres	24,593	48,571	62,645	24,191	47,933	61,887	27,565	65,787	95,411
Soil-soil surface required for increased population	Acres	519	2,640	3,242	419	2,540	3,142	559	4,184	5,386
Water-estimated water withdrawal	Acre-feet	56,090	74,405	78,275	55,820	74,135	78,000	56,200	89,985	100,490
Water-projected change in water use (Base year - 1975)	Acre-feet	11,850	30,165	34,035	11,580	29,895	33,760	11,960	45,745	56,250
Vegetation-acres of vegetation removal	Acres	24,593	48,571	62,645	24,191	47,933	61,887	27,565	65,787	95,411
Vegetation-acres of disturbed land which would be reclaimed	Acres	5,895	16,437	25,966	5,895	16,437	25,966	5,895	18,237	33,566

TABLE R8-40
(cont'd)

COMPARISON TABLE OF IMPACTS
(Partial Listing)

	Units	Regional Cumulative 1980	Regional Cumulative 1985	Regional Cumulative 1990	Cumulative No Action Alternative Low-Level Scenario 1980	Cumulative No Action Alternative Low-Level Scenario 1985	Cumulative No Action Alternative Low-Level Scenario 1990	Cumulative High-Level Scenario 1980	Cumulative High-Level Scenario 1985	Cumulative High-Level Scenario 1990
Wildlife-loss of fish and wildlife habitat and carrying capacity-direct	Acres	24,593	48,571	62,645	24,191	47,933	61,887	27,565	65,787	95,411
Wildlife-loss of fish habitat and carrying capacity affected-indirect	Acres	104,733	188,690	237,614	102,924	185,819	234,203	117,927	263,714	381,713
Wildlife-estimated loss of nongame birds	Number birds	113,870	377,545	687,170	111,595	371,880	678,235	125,145	500,625	1,023,885
Wildlife-estimated loss of raptor numbers	Number raptors	130	370	615	125	365	605	145	490	915
Wildlife-total estimated loss of nongame mammals	Millions mammals	949,735	3,864,835	7,484,510	930,740	3,806,860	7,387,210	1,043,760	5,124,770	11,151,920
Wildlife-number of antelope lost	Number antelope	200	570	955	195	560	945	220	755	1,425
Wildlife-number of deer lost	Number deer	115	345	590	115	340	585	125	460	880
Visual-VRM class change from present on disturbed lands	Acres	24,593	48,571	62,645	24,191	47,933	61,887	27,565	65,787	95,411

TABLE R8-40
(cont'd)

COMPARISON TABLE OF IMPACTS
(Partial Listing)

	Units	Regional Cumulative			Cumulative No Action Alternative Low-Level Scenario			Cumulative High-Level Scenario		
		1980	1985	1990	1980	1985	1990	1980	1985	1990
Recreation-number of recreation visitor days for all activities	Visitor days (millions)	1.276	1.633	1.991	.931	1.551	1.911	1.276	2.531	3.265
Agriculture-number of AUMs lost	AUMs	4,918	9,714	12,528	4,838	9,586	12,377	5,513	13,157	19,072
Minerals-annual coal production	Million tons	113	170	174	111	166	170	113	271	330
Transportation-estimated vehicle registrations, increase over 1978 numbers (1978 basis: 35,891 vehicles)	Vehicles	3,289	17,190	20,533	3,243	16,305	19,759	3,387	26,334	33,779
Transportation-increase in number of coal trains eastbound	Trains/ day	29.5	42.0	43.3	29.0	40.9	42.2	29.5	69.7	86.0
Transportation-increase in number of coal trains westbound	Trains/ day	29.5	42.8	43.3	29.0	40.9	42.2	29.5	69.7	86.0
Socioeconomic-total increase in population since 1978 (Total Population)	People	3,463 (41,243)	18,095 (55,875)	21,614 (59,394)	3,414 (41,194)	17,163 (54,943)	20,799 (58,579)	3,565 (41,345)	27,720 (65,500)	35,557 (73,337)
Socioeconomic-total increase in employment since 1978 (1978 basis: 50,851)	Jobs	3,994	12,688	16,606	3,735	12,508	16,314	4,212	22,219	26,020

TABLE R8-40
(cont'd)

COMPARISON TABLE OF IMPACTS
(Partial Listing)

	Units	Regional Cumulative			Cumulative No Action Alternative Low-Level Scenario			Cumulative High-Level Scenario		
		1980	1985	1990	1980	1985	1990	1980	1985	1990
Socioeconomic-total increase in income since 1978	Million dollars	96.6	348.0	583.6	89.5	328.9	569.4	97.6	490.5	801.7
Socioeconomic-increase in retail sales since 1978	Million dollars	29.4	142.2	230.9	29.4	142.2	230.9	30.1	192.6	304.1
Socioeconomic-additional units of housing needed	Housing units			14,038			13,732			18,709
Socioeconomic-increased school enrollment (1977-78 basis: 30,570)*	Students	1,385 590	7,253 3,490	11,112 4,078	1,368 574	7,171 3,416	11,001 3,975	1,403 607	9,945 5,389	14,778 6,608
Socioeconomic-increased number of physicians and dentists needed (1977 base: 21)	Doctors and dentists	46	68	75	46	68	75	46	86	99
Socioeconomic-increased number of law enforcement personnel needed	Law officers	7	50	42	7	49	42	7	73	66

* Campbell and Converse counties based on 1977-78 enrollment of 7,252 students.

CHAPTER 9

CONSULTATION AND COORDINATION

TEAM ORGANIZATION

The Wyoming State Director of the Bureau of Land Management (BLM) was assigned lead responsibility for preparation of this environmental statement (ES). Team members from the BLM, the Geological Survey (GS), and the Forest Service (FS) were selected.

BLM provided professional specialists in the fields of air quality, wildlife, cultural resources, recreation, and socioeconomics. GS provided professionals in the fields of geology, paleontology, hydrology, and mining engineering. FS provided professionals in soils, vegetation, and agriculture.

The following consultant services were secured by contract. Centaur Management Consultants, Inc., Washington, D.C., developed the rail transportation and economic sections for the regional analysis. Radian Corporation, Austin, Texas, provided the sections on climate and air quality for the regional analysis. PEDCo Environmental, Cinncinati, Ohio, developed the site-specific climate and air quality sections.

CONSULTATION AND COORDINATION IN THE PREPARATION OF THE ENVIRONMENTAL STATEMENT

During preparation of the draft ES, members of the team consulted personnel from the following federal, state, and local agencies:

Advisory Council on Historic Preservation
Bureau of Land Management
Bureau of Mines
Environmental Protection Agency
Federal Aviation Authority
Forest Service (Bighorn and Black Hills National Forests and Thunder Basin National Grasslands)
Geological Survey
Interstate Commerce Commission
National Park Service
Office of Surface Mining
U.S. Fish and Wildlife Service
University of Wyoming
Wyoming Department of Environmental Quality provided information about the status of existing or already approved mines in the Eastern Powder River Basin, and suggested a list of mitigating measures considered feasible for mined land reclamation.
Wyoming Department of Economic Planning and Development
Wyoming Department of Health and Social Services
Wyoming Department of Revenue and Taxation
Wyoming Game and Fish Department provided wildlife population data, statistics for big game and upland game harvests and numbers of hunters, and maps of big game ranges.
Wyoming Geological Survey
Wyoming Highway Department
Wyoming Recreation Commission
Wyoming State Engineer
Wyoming State Historic Preservation Officer
Campbell County Parks and Recreation Department
Converse County Parks Commission
Converse Area Planning Office
Natrona County International Airport
Sheridan County Planning Office
Tri-County Planning Office
Casper Board of Public Utilities
City of Buffalo
City of Casper
City of Gillette/Campbell County Department of Planning and Development
City of Grand Island
City of Lusk
City of Moorcroft
City of Sundance
Douglas Recreation Center
Gillette-Campbell County Airport
Lincoln Public Services Commission

Representatives of the following private industries and groups provided additional information:

Amax Coal Company
Armco Steel
Atlantic Richfield Company
Burlington Northern Railroad
Carter Mining Company
Cordero Mining Company
Fort Fetterman Sportsmen's Association
Mountain Bell
Pacific Power and Light Company
Panhandle Eastern Pipe Line Company
Rocky Mountain Energy Company
Torrington Chamber of Commerce
Trailways Bus System
Union Pacific Railroad
Wyoming Manufactured Housing Association

COORDINATION IN THE REVIEW OF THE DRAFT ENVIRONMENTAL STATEMENT

Comments on the draft ES were requested from the following agencies and interested groups. Those marked with asterisks provided oral or written comments.

Federal

Advisory Council on Historic Preservation*
Department of Agriculture
  Soil Conservation Service*
  Forest Service*
Department of Commerce*
Department of Energy
Department of Health, Education, and Welfare*
Department of Housing and Urban Development
Department of the Interior
  Bureau of Mines*
  Bureau of Reclamation*
  U.S. Fish and Wildlife Service*
  Heritage Conservation and Recreation Service*
  National Park Service*
  Office of Surface Mining
Department of Labor
  Mining Safety and Health Administration*
  Occupational Safety and Health Administration
Department of Transportation*
Environmental Protection Agency*
Federal Power Commission
Interstate Commerce Commission
Mountain Plains Federal Regional Council
National Historic Preservation Council
Office of Economic Opportunity
Office of Management and Budget
Water Resource Council

State

State of Wyoming Clearing House coordinated comments from all interested state agencies.*

Local

Campbell County Commissioners
City of Gillette-Campbell County Department of Planning and Development*
Converse Area Planning Office*
Converse County Commissioners
Mayor, City of Douglas
Mayor, City of Gillette*
Mayor, City of Glenrock

Nongovernment Organizations

American Institute of Mining and Metallurgical Engineers
American Mining Congress
American Sportsmen's Club
Campbell County Gem and Mineral Society
Campbell County Historical Society
Campbell County Rod and Gun Club
Citizens for Orderly Energy Development
Defenders of Wildlife
Fort Fetterman Sportsmen's Association
Friends of the Earth*
Izaak Walton League
League of Women Voters
Members of the Casper District BLM Advisory Board
Murie Audubon Society
National Audubon Society
National Council of Public Land Users
National Energy Law and Policy Institute
National Environmental Health Association
National Resources and Environmental Council
National Wildlife Federation
Natural Resources Defense Council
Outdoors Unlimited
Powder River Basin Resources Council*
Powder River Wildlife Club
Rocky Mountain Center of the Environment
Shell Oil Company*
Sierra Club*
Society for Range Management
The Wilderness Society
Thunder Basin Grazing Association*
Wyoming Archeological Association
Wyoming Association of Conservation Districts
Wyoming Environmental Council
Wyoming Outdoor Coordinating Council
Wyoming Petroleum Association
Wyoming Stock Growers Association
Wyoming Wildlife Federation
Wyoming Wool Growers Association

WHERE COPIES CAN BE INSPECTED

Copies of the final ES will be available for public review at Bureau of Land Management offices throughout Wyoming and at public libraries in Albany, Campbell, Carbon, Converse, Crook, Johnson, Natrona, Niobrara, Platte, Sheridan, and Weston counties. Single copies are also available upon request from the Bureau of Land Management in Cheyenne, Wyoming as long as supplies last.

PUBLIC COMMENTS AND RESPONSES

In early 1977, the BLM held the following public meetings for the purpose of discussing land use plans for the Eastern Powder River Basin: January 31, 1977, Federal Building, Casper, Wyoming, 1:00 p.m.; February 1,

1977, Recreation Center, Gillette, Wyoming, 3:00 p.m. and 7:00 p.m.; February 2, 1977, St. James Parish Hall, Douglas, Wyoming, 3:00 p.m. and 7:00 p.m. A total of 285 people attended the five meetings. Oral and written comments resulting from those meetings were analyzed before the final land use plan was issued in July 1977. The rate and location of future coal development in the basin, and subsequent socioeconomic and water resources impacts, were the subjects that caused the most concern.

The draft ES was filed with the Environmental Protection Agency and made available to the public on October 25, 1978. Its availability and times and places for public hearings were announced in the *Federal Register* (October 26, 1978, page 50060) and by regional news media. The deadline for submission of written comment, originally established for December 11, 1978, was subsequently extended to December 26. The extension was announced in the *Federal Register* (December 15, 1978, page 58641) and by regional news media.

Public hearings were held on November 28 and 29, 1978, in Gillette and Casper, Wyoming. They were preceded by news media reminders. Hearings attendance is summarized in Table R9-1. Copies of the hearings transcripts are available for public review at BLM offices in Casper and Cheyenne.

Written comments and oral testimony from the hearings were analyzed. Those comments which presented new data, questioned facts and/or analyses, and raised questions or issues bearing directly upon the draft ES were carefully considered in preparing the final ES. Although comments pertaining to federal policy, format of the ES, and environmental analysis procedures were not responded to in the final ES, these will be made available for consideration as appropriate in the decision-making process.

The remainder of Chapter 9 is divided into three portions: (1) those oral comments derived from the hearings transcripts which were *not* duplicated in subsequent written comments from that witness, and responses; (2) written comments received on or before the December 26th deadline, and responses; and (3) written comments received after the deadline, and responses there was time to prepare. Those comments received too late for response in the final ES will be answered individually by mail.

TABLE R9-1

SUMMARY OF PUBLIC HEARINGS ON THE DRAFT ENVIRONMENTAL STATEMENT

Date	Time	Location	Attendance	Number Testifying
November 28, 1978	1:30 p.m.	Gillette, WY	26	1
November 28, 1978	7:30 p.m.	Gillette, WY	29	4
November 29, 1978	1:30 p.m.	Casper, WY	9	1
November 29, 1978	7:30 p.m.	Casper, WY	4	2
TOTAL			68	8

INDEX TO COMMENTS

TRANSCRIPT

Excerpts from testimony of
- Neal J. Isto, Shell Oil Company
- Joe Racine, City of Gillette/Campbell County Department of Planning and Development
- Reed Zars, Powder River Basin Resource Council
- Ed Swartz, Rancher
- Wally Wolfe, Human Services Confederation, Douglas
- James Resick, Powder River Basin Resource Council

WRITTEN COMMENTS

Agency, Organization, or Individual	Letter No.
Federal	
Advisory Council on Historic Preservation	32
Department of Agriculture	
Forest Service	9, 10, 25
Soil Conservation Service	27
Department of Commerce	21
Department of Health, Education, and Welfare	13
Department of the Interior	
Bureau of Mines	8
Bureau of Reclamation	12
Heritage Conservation and Recreation Service	11
National Park Service	19
U.S. Fish and Wildlife Service	6, 34
Department of Labor	
Mining Safety and Health Administration	2
Department of Transportation	30
Environmental Protection Agency	46
Federal Energy Regulatory Commission	22
State	
State of Utah, State Planning Coordinator	3
State of Wyoming	
Department of Agriculture	35
Department of Environmental Quality, Air Quality	41
Department of Environmental Quality, Water Quality	40
Game and Fish Department	44
Industrial Siting Administration	38
State Conservation Commission	1
State Engineer	36
Wyoming Highway Department	37
Wyoming Recreation Commission (3 letters)	39

INDEX TO COMMENTS
(cont'd)

Agency, Organization, or Individual	Letter No.
Local	
City of Casper	25
City of Gillette	33
Converse Area Planning Office	4
Private Organizations	
Amax Coal Company	28
Atlantic Richfield Company	45
Burgess & Davis	20
Burlington Northern	29
Carter Mining Company	23
Energy Transportation Systems Inc.	15
Powder River Basin Resource Council	26, 31, 42
Shell Oil Company	14
Sierra Club/Friends of the Earth	17
Texas Energy Services	16, 47
Thunder Basin Grazing Association	18
Wyoming Timber Industry Association	7
Individuals	
Wiliam E. Greer	5
Mark Onstott	43

TRANSCRIPT COMMENTS AND RESPONSES

Neal J. Isto, Shell Oil Company

1. We have been working closely with the Gillette/Campbell County planning commission on the housing situation. We have supplied them with our projected employment levels. We are also aware of Gillette's temporary housing needs, and we intend to arrange for facilities to house construction workers near the mine site.

Response. This information has been incorporated in Chapter 1 of the site-specific analysis.

Joe Racine, City of Gillette/Campbell County Department of Planning and Development

2. I believe the impact statement oversimplifies the housing problem. It talks about the ability of the Buckskin Mine employees to afford single family housing. It does not get into sufficient details in the difficulties of providing for construction of houses, nor does it recognize the fact that most of the Buckskin employees will probably tend to be young people who do not have sufficient downpayment monies to get into a single family house early on.

Response. The housing section in Chapter 3 of the site-specific analysis quantifies the number of households desiring but unable to afford single-family housing. The problems and costs of housing construction in Gillette are discussed in Chapter 2 of the site-specific analysis. We have no information about the ages or economic circumstances of prospective Buckskin employees.

3. I do also request that if local information is not being used, that the reference on page R9-1 relative to consultation with my department in particular, be stricken from the book, if the information we have available is not used.

Response. Socioeconomic information, particularly population figures, were revised in the final ES on the basis of information provided by the City of Gillette/Campbell County Department of Planning and Development, the Converse Area Planning Office, and the City of Casper. Hence, the references in Chapter 9 have been retained.

Reed Zars, Powder River Basin Resource Council

4. It seems as though this statement was built upon the mines who had submitted their environmental information for a draft environmental statement, and then all existing mines--personally I know of several others that are planning on coming in, and some of these are already submitted for their land quality permits, ... I am familiar with several expansions of mines that didn't seem to be discussed, ...

Response. Our most probable production scenario was based upon our best judgement after consideration of all relevant and available information.

Other mines for which mining and reclamation plans have been submitted recently or which are expected in the near future are included in the high-level scenario; a site-specific environmental analysis will be prepared for each new mine.

5. I have worked with a lot of people down in Southern Campbell County, where the majority of this impact is being felt, and there is a 230 KV line that is going through, and that is discussed in the impact statement, of course, but 69 KV line, all the feeders that have to go to these mines, and have to link up to the 230 KV lines and with the existing 69 KV lines, don't appear to be discussed. Now, that is a fairly significant impact. Again, you have between 15 and 18 acres per mile of right-of-way that is needed for power lines in that area.

Response. The amount of acreage disturbed by 69-kv feeder lines for the coal mines is included in cumulative regional surface disturbance. See Tables R1-3, R1-4, and R1-5.

6. Also slurry lines, I would like to have some indication of where they might be, and I know that a slurry line is being proposed in this area, and what mines it might be going to and what acreage implication that will bring about. I think we should get into that a little more.

Response. Please see response 29-9.

7. I have some major problems all of the air quality data that was put out in this statement. They predict, or somebody predicted, that in 1990, the total emissions from the mines would be 41,513 tons. I have been fairly familiar in working with these air quality permits that PEDCO study indicated, and my figures come out to 296,000 tons per year in 1990. I would state that this is a 700 percent underestimation of the air quality impact in this area. Also, some people will argue that this fugitive dust problem isn't really anything to worry about, but if we take the 296,000 tons per year, which I estimate would be pumped out of these mines into the air in 1990, 44,000 tons of that will be respirable. That means it is less than 10 microns, and can be inhaled into your lungs and cannot be coughed out. And that particulate matter tends to stay in the air for quite a long period, and is very damaging, not only to people, but to livestock.

Response. The estimate of total emissions given in the ES was based on the information available at the time the analysis was performed. The difference between the emissions figures given in the ES and the figure given in the comment could be due to one or more of the following reasons:

1) The figures presented in the comment were based on more mines than were analyzed in the ES.

2) In the comment, a figure of 1,750 tons per year per million tons of coal mined was used to derive the emissions figures. The ES analysis used a figure of 1.2 pounds per year per ton of coal or 600 tons per million tons of coal mined. The figure used in the ES analysis was based on the PEDCO (1978) study.

3) The calculation of the figures given in the comment may not have included the decrease in emissions associated with the mitigating measures outlined in the mining and reclamation plans submitted by the coal companies and the decrease associated with the use of best available control technology. Both of these factors were used in the ES analysis.

It is not clear how the determination of the quantity of dust in the respirable range (stated in the comment as below 10 microns; it is, in fact, in the .2 to 2 micron range) was made. It is normally necessary to establish the particle size distribution for a given aerosol to make this determination. None was made in connection with the ES analysis and none was presented or referenced in the comment.

8. I think it is interesting to note that the annual 24-hour standard will be violated in Gillette in 1990. I don't understand how significant that will be or for what term, but I think Gillette ought to really start looking at what air quality impact these mines are going to bring.

Response. The ES states that Wyoming annual and 24-hour standards for total suspended particulates may occur (Chapter 4 of the regional analysis) or would occur (Chapter 8, high-level scenario) in Gillette by 1990. However, it is further stated that with application of EPA's 43 CFR 118 regulations, no violations of standards would likely occur.

Significance of these changes in air quality cannot be expressed in human terms rather than numerical ones; effects on the human environment are dependent on particle size and chemical composition which are impossible to predict. A deterioration in air quality in Gillette would last for the life of the mines close to Gillette.

9. Also it is discussed in the impact statement that the exemption of fugitive dust exemption by the EPA this year means that there won't be any violation. I hope the Panel here and other people understand that is only an interim regulation, and hasn't been formally adopted by the EPA.

Response. The EPA regulations regarding fugitive dust (43 CFR 118) are interim, but were formally adopted after hearings and public comment procedures.

10. I think there are some glaring deficiencies also in the regional assessment of air quality in that all vehicle emissions were ignored. I think that is a very large mistake. The vehicle emissions on these dry county roads are very considerable, and the exhaust emissions here in town are getting to be pretty heavy too.

Response. The emissions from vehicles were not ignored. Exhaust emissions in cities are included in the projected levels of total suspended particulates and gaseous pollutants in urban areas. Exhaust emissions in rural areas and dust stirred up by vehicles on unpaved roads were considered in the impact analysis and probably contribute to baseline TSP and gaseous pollutant concentrations (see Chapter 2 of the regional analysis, Air Quality). Because vehicle-related fugitive dust and exhaust emissions come from intermittent sources, they were not included in air quality projections. The text has been amended to make these points clearer. See Chapter 4 of the regional analysis.

11. I would also like to make a short comment. It says construction impacts are not significant.

Response. The ES states that effects of construction on air quality would be temporary and would affect small areas. The impacts are therefore considered minor, not insignificant.

12. Also, I think the figures themselves are suspect and low because they did not consider car kills, wanton shooting, which is getting more and more prevalent and harassment by dogs, which are just another process that is also killing quite a bit of wildlife in the area. I think you ought to take into account all those other impacts.

Response. Figures for projected increases in game violations (including wanton shooting) and vehicle kills are available and have been added to the final ES. Figures for increased game losses due to harassment by domestic pets and train collisions are unquantifiable.

13. Fire, as discussed, this impact statement says, that the loss of vegetation due to fire will increase by 50 percent in 1990, and again you have to recognize that this is a grassland area, and most of the agriculture that is ongoing in the area depends on that grass, and to have a lot of fire, people throwing cigarettes out of their cars or hotboxes on railroad cars, you are going to then cut into agricultural productivity and ability of people to maintain sort of an ongoing agricultural process, which is really the one long term industry that is capable of maintaining itself here.

Response. As pointed out in the ES, the potential for fires would increase due to increased development. On the other hand, the ability to control fire would improve through better access, more people to discover, report, and fight fire, and more equipment. Fire could well have a significant short-term impact on agriculture, especially for the rancher who suffers a severe fire loss. Past experience indicates the ranges do recover from wildfire and are occassionally enhanced by fire.

14. Another big issue, water, as far as I can see, I think the consumption was grossly underestimated for coal mining in this area. . . . It doesn't mention the fact that approximately 217 acre-feet is inherent in each million tons of coal . . . and we are desiccating this land by mining all of that coal, which holds an incredible amount of water.

Response. Water in the coal that constitutes the moisture analysis is not available to either wells or plants. This is analogous to a soil which may have 15% moisture content but not have moisture available to plants. If this soil lost all its moisture, moisture to 15% plus of the volume would have to be added before any moisture was available to the plants. Removal of the coal does not constitute an impact to available regional water resources.

15. I had hoped this statement might look into the loads that are placed on existing power suppliers in the area. I have worked with this a little bit. I have got some figures I could throw out and maybe get the people in gear. I figured something around 1,000 kilowatts are demanded

per million tons of coal that entered-- let's see, I had better start again. One thousand kilowatts of energy by my figures are demanded for each additional million tons of coal that are mined in this area. Also, I think we ought to look into consumption of electricity consumed per ton of coal. I have on the average two to three kilowatt hours consumed per ton of coal mined. I would like the people here to check into see what that does in increasing electrical usage in the region and what that might do to original users in the area, and their rates. Are they having to subsidize this increase?

Response. The figures Mr. Zars cites agree with those of the Tri-County Electric Association, Inc. (Ecology Consultants 1976), which means power usage by coal mines would be about 272.5 million kwh, 421.5 million kwh, and 433.2 million kwh 1980, 1985, and 1990, respectively. The 230-kv line, to be constructed as discussed in Chapter 1 of the regional analysis, is designed to supply power demands of future mineral development so that power shortages do not occur. Pacific Power and Light Company (PP&L) operates on a cost recovery basis. They base rates on a given cost plus a certain amount of return. PP&L is regulated by the Public Service Commission of Wyoming (PSC), and PP&L cannot change any rate structures unless approved by the PSC. In recent years, as there is an increase in use of electricity, there is a cost increase to all customers. This is due mainly to the increased cost of resources used to generate and transport electricity.

16. All right, I will swing into the maps. I guess I only have one there, and that is what is called a "Regional Activity Map", is that correct? I think that on that map we ought to have all of the state leases put on there. By my reckoning, I think every state lease in Campbell and Converse County has been leased. Maybe one or two is left. I am not sure. But that is coming out to around 400 square miles of area, and I think we ought to get that on the map, and also discuss that as to what affect that will have on the impact of the area. I think people are considering mining those state leases along with federal.

Response. As of 1976, 493.4 square miles (or nearly all) of state land containing economically recoverable coal were under lease in the region (Glass 1976b). Most of these coal lands occur in scattered sections and are not economically minable without adjoining federal leases and/or fee coal, so the impact on regional development of the state leases alone is not considered significant. Map 3 in Appendix A shows mineral ownership, and this is adequate for the purposes of this ES.

17. I think there is a new Gillette citizen poll that came out in 1978. I think the 1977 one is referenced in there. You might be interested in picking that up and getting a little update.

Response. Information from the most recent poll has been incorporated in the final ES.

18. One thing I want to interject is, that a lot of the ranchers and farmers who live just west of the major coal outcrops of the major mines are being run through with a lot of transmission lines, and no one wants to put any of that facility on mineable coal, so they go over here and run their rail lines and car lines and everything else off of that coal, but

then on to the ranchers, and they are really having a lot of their land tied up by easements, and you can't build your shed or windbreak or anything of that order on it, and it really starts tying your land up, and we are having telephone lines and power lines pipelines and really getting to be a big right-of-way problem in this concentrated area, and it is a hard thing to handle, and it is a very significant impact once it is built upon.

Response. Response 20-1 explains that the Bureau of Land Management does have a policy regarding construction of transmission lines, but this policy is applicable only to rights-of-way on federal surface. More than 75% of the land surface in the region is privately owned, where locations of new powerlines could be controlled by state or county policy. Whether landowners grant permission for easements or the utility companies use condemnation procedures, the landowners are compensated to some degree for the use of their land. The visual impacts of powerline construction are discussed in Chapter 4 of the regional analysis as are impacts on agricultural operations.

Ed Swartz, Rancher

19. One thing that has never been clarified in my mind is, there are many of these prospecting permits still outstanding. I don't know whether those are under the control of the people who are going to make the decision of whether to issue any new leases in the Powder River Basin. If those are under the status of when they were originally issued, if they find some minable coal, they can go ahead and obtain a lease without any type of competitive bid or anything like that. This, to me, is a rip off to the people, and it is going to put a lot more coal land out, and is going to add a lot of impact.

Response. The Bureau of Land Management by written decision has rejected all coal prospecting permits in Wyoming. However, some of these decisions have been appealed and are presently in litigation.

Wally Wolfe, Human Services Confederation, Douglas

20. (The report) is not addressing, it seems to me, the human problems that occur because of energy development . . . For instance, the child abuse rate, . . . the (need for) rehabilitation of handicapped or disabled individuals . . . the need for foster or group home placements.

Response. The problems and statistics presented in this comment have been incorporated in the text. See Chapter 4 of the regional analysis.

James Resick, Powder River Basin Resource Council

21. I feel that the numbers do not reflect individual open pit solution and deep mine projects which are expected to be constructed in the very near future, nor those planned by companies for long range construction.

Response. We have updated much of our uranium data according to information provided by Wyoming Department of Economic Planning and Development (see response 26-1). As stated in Chapter 1 of the regional analysis, each uranium operation may consist of several open pit, solution, or

underground mines, developed concurrently or consecutively, depending on the distribution of ore bodies.

22. I bring this up, because I feel two conclusions can be made. First of all, there has been no real long term assessment of the amount of uranium mining that will take place.

The second conclusion that I come to, and in looking at this chart is, that it might be better from the format perspective to display the number of open pit and deep mines and solution mines which are projected for the Basin.

Response. The subject of this ES is the impacts of possible coal development in the region. The impacts of projected uranium development are included in the cumulative regional impact assessment. See also transcript response #21 and response 26-6.

23. Based on information available from the Wyoming Industrial Siting Administration, I believe that the annual water requirement for coal fired power plants has been projected too low.

Response. See response 15-1.

24. Looking also now at uranium operations, the water requirements as estimated for uranium operations . . . does not reflect . . . the amount of acre-feet which they intend to take from deep aquifers . . . and put it into the water courses.

Response. All water pumped from deep aquifers cannot be considered consumed. Consumed, as used in reference to water, usually refers to loss by evaporation or transpiration. In irrigation, for example, water that returns to the stream or the groundwater is not considered consumed. Some water pumped from deep uranium mines into formerly dry stream beds would evaporate, some would be taken up by plants, and some would flow into larger streams or return to the groundwater. Flowing water in a formerly dry stream bed can be considered beneficial for vegetation, livestock, and wildlife, if the water is of good quality.

See transcript responses #21 and #22 for an explanation of the depth of uranium mining impact analysis.

25. I guess the upshot of what I am pointing out with regards to uranium development in the Basin. I feel the environmental statement should assess more completely the probable levels of uranium production as well as concomitant impacts on water quantity and water quality. I think the cumulative affect on water supplies may be, much different then what has been assessed or estimated in the project during the environmental statement. I feel also that the high and low levels scenarios under the alternative selection under the environmental statement should assess in addition to the coal production in low and high level scenarios, it should also address high and low levels estimates for uranium production.

Response. See transcript responses #21 and #22 and response 26-6.

The following are written comments received on or before the December 26, 1978, deadline, and their responses.

1

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

State Conservation Commission

2219 CAREY AVENUE PHONE (307) 777-7321 CHEYENNE, WYOMING 82002

WAYNE A. EDGERTON
CONSERVATION COMMISSION STATE EXECUTIVE

TIMOTHY J. KAUTZA
DISTRICT PROGRAM CONSULTANT

DWIGHT KIMSEY
208 WATER QUALITY COORDINATOR

November 1, 1978

M E M O R A N D U M

TO: Wyoming State Bureau of Land Management

FROM: Wyoming State Conservation Commission Wayne A. Edgerton

SUBJECT: DRAFT ENVIRONMENTAL STATEMENT: PROPOSED DEVELOPMENT OF COAL RESOURCES IN THE EASTERN POWDER RIVER BASIN OF WYOMING (BUCKSKIN MINE)

I have reviewed the above named subject and offer the following comments for your consideration.

The descriptive soils information appears adequate for both the regional and site specific statements. However, I bring to your attention some possibly misleading information concerning topsoil handling and postmining use of the land.

1 "Topsoil Handling (30 CFR 715.16)" (page BU4-17) states, "If a greater depth of topsoil material were replaced, such as 30 inches, along with the appropriate soil amendments, the long-term productivity of the site should equal or exceed the premining productivity." On what study or data was this prediction based?

2 "Postmining Use of Land (30 CFR 715.13)" (page BU4-1) states, "Long term soil productivity (and hence vegetative productivity) would eventually stabilize at 87% of premining levels on the Buckskin site, unless some modification of the reclamation plan raises the productivity." The methodology used to calculate the productivity is taken from "Potential Soil Capability Classification for Reclamation" by Rounsaville. Restoration of disturbed lands should require total consideration of soil, water, and plant management systems as related to the climatic conditions of a specific site. Evidence is not provided to show that all necessary factors were considered when calculating future productivity of the reclaimed lands. The Rounsaville method has not been verified on mined lands, so why is it used to estimate anticipated soil productivity, when research has and is being done on mine sites?

PROTECT OUR HERITAGE
through the
Conservation of Wyoming's Natural Resources

1

Bureau of Land Management
November 1, 1978
Page Two

The publication, Soil, Water, Air and Sciences Research Annual Report, by the Science and Education Administration, supplies a list of publications concerning reclamation of mined land and also provides examples of recent progress made in the field.

TJK:mn
cc: Don Daise, Assistant Commissioner of Agriculture

Letter 1 Responses

1. This prediction was based on the same document on which the remainder of the soils analysis of the Buckskin mining and reclamation plan was based, that is, Soil Investigation Specifications for Mining and Reclamation Proposals by Hayden Rounsaville, USDA--Forest Service, which, in turn, was based on the land capability and range site system of the USDA--Soil Conservation Service.

2. The proper name of the document used is Soil Investigation Specifications for Mining and Reclamation Proposals by Hayden Rounsaville, USDA--Forest Service. The text has been corrected. This document considers both physical and chemical properties of the soils present on each site and plant management systems as related to the climatic conditions of northeastern Wyoming. Abundant evidence shows that the soils resource available is the most important factor in successful reclamation, and this document provides the most consistent means for evaluating the soils resource in mining and reclamation proposals to date. This document concerns itself with the long-term capability (productivity) of the reclaimed site. Examples of apparent success in recent reclamation efforts would be meaningless in the long-term sense (more than 50 years), since the reclamation effort (with native species) on the northern plains is a method used only recently.

2

U.S. DEPARTMENT OF LABOR
MINE SAFETY AND HEALTH ADMINISTRATION
4015 Wilson Boulevard
Arlington, Virginia 22203

NOV 7 1978

Team Leader
Bureau of Land Management
Coal ES Team
951 Union Boulevard
Casper, Wyoming 82601

Dear Sir:

In response to your undated letter (Reference 1792 (920)), we have only a few comments concerning your draft environmental statement for the Eastern Powder River Coal Region of Wyoming.

The information and analyses provided by the statement seem adequate and detailed in scope. None of the described environmental or socio-economic factors would have any affect on our program other than to require additional inspection and enforcement activities when new mines are eventually opened.

We thank you for the opportunity to provide these comments.

Sincerely,

Robert B. Lagather

Robert B. Lagather
Assistant Secretary for
Mine Safety and Health

Letter 2

No response required.

3

Scott M. Matheson
Governor

Kent Briggs
State Planning Coordinator

STATE OF UTAH
Office of the
STATE PLANNING COORDINATOR
118 State Capitol
Salt Lake City, Utah 84114
(801) 533-5245

November 22, 1978

Team Leader
Coal ES Team
951 Union Blvd.
Casper, WY 82601

Dear Sir:

The Utah State Environmental Coordinating Committee has reviewed the Draft Environmental Impact Statement for the Eastern Powder River Coal, Cheyenne, Wyoming. The Committee offers no comment.

Thank you for the opportunity to comment.

Sincerely,

Lorayne Tempest

Lorayne Tempest
Assistant State Planning Coordinator

LT/jb F-1

Letter 3

No response required.

4

CITY OF GILLETTE — CAMPBELL COUNTY

Department of Planning and Development

P.O. BOX 3003 GILLETTE, WYOMING 82716 PHONE (307) 686-2222

November 28, 1978

Ms. Julie Elfving
U.S. Department of Interior
Bureau of Land Management
Casper, Wyoming 82601

Re: Draft Environmental Statement, Eastern Powder River Coal, Public Hearing, Gillette, Wyoming - November 28, 1978

Dear Ms. Elfving,

Mr. Al Strassle, Director of the Converse Area Planning Office, will be unable to attend the public hearing in Gillette on November 28th. He has, however, asked that I present the attached material on his behalf relative to the draft environmental statement - Eastern Powder River Coal. I will present his concerns along with my testimony at the public hearing on November 28th.

I hope this information will be considered in the preparation of the final environmental statement. Both Al and I encourage you to consult with us in the preparation of the final statement.

Very truly yours,

Joseph A. Racine
Director

JAR/lgw
Attachment
cc/ Al Strassle

4

Converse County Municipal and County Joint Powers Board

Glenrock—Douglas—Converse County

Converse County Courthouse
Box 1303
Douglas, Wyoming 82633

(307) 358-4066

CONVERSE AREA PLANNING OFFICE

November 24, 1978

Joe Racine
Dept. of Planning and Development
Box 3003
Gillette, Wyo 82716

Re: Draft Environmental Statement - Eastern Powder River Coal

Dear Joe,

Pursuant to our telephone conversation this afternoon, I have reviewed portions of the Draft Environmental Impact Statement. I feel some of the comments that relate to Douglas and Converse County are equally applicable to your local governments. While I have other obligations and cannot be at the hearing, I will furnish you with my concerns and will send a copy to the Bureau of Land Management.

1 Population Estimates - It would appear that we have a recurring problem with population estimates for our counties. Our office has done population estimates and projections for Douglas, Glenrock, and Converse County. Comparing those to Table R4-13 on Page R4-45 of the Environmental Impact Statement, I questions the validity of those population projections in the Impact Statement. The estimated population in the Impact Statement for Douglas, for example, is what we estimated our population to be in 1974. That is four years ago. The Table in the Environmental Impact Statement makes some reference to the University of Wyoming in 1978, and in checking the bibliography, there does not appear to be anything definitive in that reference source. Not knowing the methodology used in the population projections in the Environmental Impact Statement, I can only state the methodology used by this office. That being that an inventory of the Assessor's records was made on all dwelling units in Converse County of single-famioy residence, multi-family or apartment, and those records updated with building permits issued in the towns of Glenrock and Douglas; the HUD reporting forms were furnished us by the Building Inspectors of the two towns. These estimates were cross-checked with the franchised utilities in the towns, and with the towns' water usage and water meters.

Using the above method, we feel we have a valid base from which to project our population. Once this base was established, employment figures from the major employees within the County were given us, and these figures plugged into the basic service multipliers and the projections given over the next six years.

4

Joe Racine
November 24, 1978
Page two

1 I personally feel, especially in the case of Converse County and its towns, that the accumulative population projections in the Environmental Impact Statement are invalid due to the simple fact that the 1980 estimated population is approximately 3,000 people less, in the case of Douglas, than the population now being served in the Town of Douglas by municipal services and the other utilities. A copy of our office's population projections are enclosed. The copy will further explain the method by which population is projected within this county.

2 The next area of concern I have is in Housing. On Page R4-51, Table R4-16, Projected Cumulative Housing Demand. The 1977 Housing Stock for Douglas and Glenrock are obviously taken from the Land Use and Housing Plan of Converse County prepared in December of 1977 by this office. Unless the same methods were used for the other cities on the chart, it would be difficult to compare figures between the various towns. Before the above referenced Table could be considered usable, I believe the source for the 1977 Housing Stock information should be noted and a check made for consistency between the various municipalities to see if the figures are comparable. Also in presentation of the information on the chart, it is difficult to understand what is taking place where 1977 Housing Stock information is given. Then, there is another column noted, "The Additional Demand for Housing Units", and it gives the 1977-1990 total number of units. Not knowing whether those are additional units above the 1977 Housing Stock and the various categories for the cumulative number of units with the additional being added to the 1977 stock, i.e., in the case of Gillette. Total housing units 3,845 were the 1977-1990 total number of units, 4,093. Is that 4,093 additional units, or is that 148 housing units in addition to those existing in 1977? The chart is confusing on this point.

I woul hope that you would be able to review my comments in light of the situation in the City of Gillette and Campbell County. If my criticism seems appropriate, please present it for the two of us on the date of the hearing.

If you have any questions concerning this, feel free to contact me at your convenience.

Sincerely,

A. R. Straessle, Director
Converse Area Planning Office

cc: FRBRC
BLM

Enclosures

Letter 4 Responses

1. Thank you for the revised population data. We have used information provided by the Converse Area Planning Office, the City of Casper, and the City of Gillette/Campbell County Department of Planning and Development to revise population base and projection figures in the ES. See particularly Chapters 2, 4, and 8 of the regional analysis.

2. It is ackowledged that municipalities may differ in their estimating procedures. However, the table is not used to make comparisons among municipalities. Rather, the current housing inventory in each community--in terms of number and types of dwelling units--is compared with projected trends in housing demand for that community. The heading on the table has been altered to eliminate confusion, and a source line has been added.

WILLIAM E. GREER 5
Box 815
Gillette, Wyoming
82716

Nov. 28, 1978

In relation to the hearing held in Gillette Nov. 28, I am writing to make a comment or two.

Living just 2½ to 3 miles North of the Carter Caballo and AMAX mines South of Gillette, we have experienced about all the impact problems (traffic, trespassers, poaching, trash dumping, housing developments, etc) and are constantly threatened with Power Lines and Rail roads cutting up our deeded and leased lands. I don't know how much "progress" we can stand.

However, the main thing I would like to tell you about is a more urgent problem. We have 2 wells that have recently dropped down to barely pumping

5

-2-

but, for years, have pumped 9-14 gallon per minute. The water level has just continued to fall this past year. Also one permanent spring has quit flowing completely.

Of course, we can not prove it, but I firmly believe the vast amounts of water they are pumping out at the coal mine areas are effecting our water supplies.

In spite of what the coal companies say, I think they are <u>indirectly</u> destroying our land, our way of life and are not concerned about the rancher.

Respectfully yours,

Bill Greer

<u>Letter 5 Responses</u>

1. Chapter 4 of the regional analysis recognizes the potential for mining operations to adversely affect water supplies. The section on laws and regulations in Chapter 3 of the regional analysis has been expanded to include a section on water rights.

6

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Billings Area Office
Federal Building, Room 3035
316 North 26th Street
Billings, Montana 59101

IN REPLY REFER TO:
ES--EC #78/49

November 30, 1978

MEMORANDUM

TO : Team Leader, Coal ES Team, Bureau of Land Management, 951 Union Blvd., Casper, WY 82601

FROM : Area Manager, Billings, MT (ES)

SUBJECT: Review of Draft EIS for Eastern Powder River Coal Region of Wyoming (EC 78/49)

We have reviewed the parts of the subject EIS that are pertinent to our expertise. We have only minimal comments. These follow:

We are concerned, but realize that interim regulations are so written, that reclamation <u>must</u> include plant species valuable to wildlife only if wildlife is to be a post-mining land use. However, we believe the regulations will permit, and we much prefer, to see plants species beneficial to wildlife become part of <u>any</u> reclamation seeding program regardless of the post-mining land use designation.

1 Several times in the draft EIS the wildlife mitigation alternative recommends that wildlife habitat be restored using "all possible means and regardless of cost." We strongly support the concept of wildlife mitigation and habitat restoration. However, we feel that caution should be exercised in the wording of such recommendations. We suggest the referred to language be reworded to reflect the idea that, "all reasonable means" should always be employed, but without suggesting that cost should <u>never</u> be considered in determining what is "reasonable."

2 On page R3-6, under Vegetative Wildlife, it is stated that the Bald Eagle Act prohibits mining where it would disturb eagles. This is not entirely correct. The Act does prohibit molestation of eagles and their nests. However, it does not mention specific activities such as mining in connection with the provision. In this regard, it should be mentioned that recent amendments in the Act authorize the Secretary of the Interior to promulgate regulations to permit "the taking of golden eagle nests which interfere with resource developments or recovery operations." The regulations have not yet been formulated.

6

3 In general, we believe this statement is one of the better ones we have reviewed. It might be more understandable if mitigation measures could be better identified with and related to associated impacts.

cc: Regional Director, USFWS, Denver, CO (ENV)
FWS/EC/ES, Washington D.C.

Letter 6 Responses

1. The text has been changed to incorporate these suggestions.

2. The text has been revised to incorporate these statements.

3. Mitigating measures for the site-specific analysis are identified with impacts in Table BU4-1.

7

Wyoming timber industry Association

December 1, 1978

Team Leader
Coal ES Team
951 Union Blvd.
Casper, WY 82601

Dear Sir:

We would like to thank you for the opportunity to comment on the draft environmental statement for Eastern Powder River Coal. As the draft statement mentions, there is very little commercial timber land in this area.

1 On page R2-71 under "Forest Resources" in the paragraph two, you address sawtimber primarily. In paragraph three you mention post, poles, cones, fuel wood, etc. Then in the fourth paragraph you are talking about wood fiber. We cannot disagree with the generalized statement, but it gives a false impression. There are good stands of timber in the northern part of Campbell County, but they are small in acreage. Even with all the timber in the area, the reason for the lack of timber industry development is primarily based on the scattered nature of the good stands of timber along with the poor quality and stocking of the remaining timber. There is enough wood fiber in the area to support some type of timber industry, but the transportation costs do not make it economical at the present time.

2 In the concluding paragraph (paragraph four), you state ". . . ponderosa pine forests are considerably more important for wildlife habitat and recreation than for wood fiber." We question the importance of the area for recreation except possibly hunting. There is little water or other recreational uses in this area.

Bruce Barker, President
Wyoming Timber Industry Association

cc:Bryce Lundell

BB/je

Letter 7 Responses

1. The text has been revised to indicate that there are scattered stands of sawtimber-size trees. See Chapter 2 of the regional analysis, Forest Resources.

2. The text says "considered" (not "considerably") more important. It is true that the main form of recreational use is hunting; however, picnicking and camping have been observed in these forests. The text has been revised to indicate that the main form of recreational use is hunting. See Chapter 2 of the regional analysis, Forest Resources.

8

OFFICE OF THE DIRECTOR

United States Department of the Interior
BUREAU OF MINES
2401 E STREET, NW.
WASHINGTON, D.C. 20241

December 5, 1978

Memorandum

To: Team Leader, Coal ES Team, Casper, Wyoming

From: Director, Bureau of Mines

Subject: Eastern Powder River Regional Coal Environmental Statement

This environmental statement covers an area that will probably be a major source of coal production for many years. The statement in general is well done, and we offer the following comments to strengthen and improve the mineral resources discussion.

1 The statement notes that minable coal underlies 90 percent of the area and represents 50 percent of Wyoming's coal and 84 percent of its strippable coal, but more should be said about the national importance and unique character of the unusually large resource of strippable, low-sulfur, thick-bedded coal that occurs here.

2 An important relationship illustrated on the maps of appendix A that should be more thoroughly discussed in the text is the extensive private surface ownership (75 percent is a number used) but the high Federal mineral ownership. The cooperation required between private surface owners and the Federal mineral managers to effect efficient development of the mineral resource is a consideration in determining a Federal course of action and should be addressed more specifically.

3 An important conservation and cost factor that deserves discussion in the chapter on alternatives is the fact that the thick coalbeds found in the Eastern Powder River area permit a large volume of coal to be produced per unit of surface area disturbed with less coal resource loss.

4 On page BU3-31 in the section on mineral resources, the ". . . consumption and loss of coal resources," is stated as an impact. We do not believe that utilization of a resource should be equated with a "loss" of that resource and suggest deleting the word. It is not used in this context elsewhere in the statement.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

5 A map identifying mines and other resource locations would be appropriate in chapter 1, Description of Regional Development. There are a number of good maps in chapter 2 and map R8-10 in chapter 3 that would be more helpful in chapter 1.

Results of surveys on local attitudes toward development, given in the description of the present regional environment, are more extensive than seen elsewhere and present interesting insight into that side of the mine development proposal.

As was done in the southeast Wyoming regional coal environmental statement, the transposition of the subject matter in chapters 3 and 4 from their normal order seems to make sense by avoiding setting up potential impacts, which then are routinely disposed of by application of existing laws and regulations. This helps focus in on the real potential problems.

Overall, we consider this to be an exceptionally well done environmental statement, and we appreciate the opportunity to review it.

Acting Director

Letter 8 Responses

1. The text has been revised. See Chapter 2 of the regional analysis, Mineral Resources.

2. Chapter 3 of the regional analysis, Institutional Relationships, Relationship with Private Interests, discusses the relationship of federal (and state) mineral managers and private surface owners. The percentages of federal, state, and private surface and mineral ownerships have been added.

3. The draft ES on the Federal Coal Management Program (December 15, 1978) discusses this and other matters which involve national rather than regional consideration.

4. The text has been revised. See Chapter 3 of the site-specific analysis, Mineral Resources.

5. Map 1 in Appendix A shows the regional developments discussed in Chapter 1. Figure R8-10 shows locations of possible future coal development under the high-level scenario; it is not relevant to Chapter 1.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Thunder Basin National Grassland
809 South 9th Street
Douglas, Wyoming 82633

2820
December 4, 1978

Team Leader
Coal ES Team
951 Union Blvd.
Casper, Wyoming 82601

Dear Sir:

The following are the comments and points I feel should be considered in the preparation of the final Eastern Powder River Coal Environmental Statement:

A. Chapter 2, Regional Analysis

1 1. Page R2-44: Endangered and/or Threatened Species
The Bald Eagle is a winter resident, especially along the Cheyenne River Forks, Antelope Creek, Porcupine Creek and the North Platte River.

2 2. Appendix A, Map #7 - Black tailed prairie dogs.
Thirty-nine towns have been identified on Thunder Basin National Grassland compared with fourteen shown by your map.

3 3. Chapter 3, Page R3-9 - U.S. Forest Service Planning.
The overall objectives on the Grasslands emanate from the Multiple-Use Sustained Yield Act of 1960, the Forest and Rangeland Resources Planning Act of 1974 (RPA) and the National Forest Management Act of 1976.

B. Proposed Buckskin Mine

4 1. Chapter 1, Page BU1-17 - Present and Future Land Use.
It seems to me that only token consideration is given to reclaiming the area for wildlife habitat. How many wildlife areas will there be? Why not reintroduce big sagebrush in suitable areas or at least replace the shrub component.

6200-11 (3/69)

5 2. Shaping of Overburden.
No consideration given to leaving highwalls for raptor nesting sites; etc. - south and east aspects would be best.

6 3. General Comments.

a. Map 5 is inaccurate, especially in location of riparian areas as on Sand Creek in Converse County.

7 b. Mis-identification of Antelope Creek below junction with Porcupine Creek as the South Fork Cheyenne River.

C. Soils Portion of the Proposed Buckskin Mine

8 It seems as though the 87 percent vegetation and soil productivity figure is a liberal interpretation. Considering the post-mining contours, there may be as much as 100 acres around the perimeter where slopes exceed 30 percent. Approximately one-half of these slopes will be on south or west aspects. A considerable amount of water can be expected to be lost as runoff or increased evapotranspiration from these areas. Landforms with these properties will act as shallow loamy range sites, as previously postulated. This would reduce average productivity from 1200 to 900 pounds per acre on about 100 acres, and would decrease overall productivity to less than 85 percent of original, further degrading reclamation potential.

9 The regraded highwalls may prove very difficult to reclaim. One experience has shown that overburden dumps with 3:1 sideslopes exhibited severe hill and gully erosion during this Spring's precipitation. This problem could occur along Spring Draw on the north side of the proposed Buckskin Mine site. Regraded spoils piles should be taken to a 5:1 slope in every case to mitigate the above comments.

10 It should be noted that on the Buckskin Mine site, two soils are present where there may be excess suitable material outside the range of the standard soil survey. The Haverson and Olney series may have suitable material below a depth of 50 or 60 inches that is normally not considered in mapping the surface soils. Another noteworthy item is the fact that the

10 heavy clay loam and clay subsoils of the Renohill Soil Series may be suitable for subsoil replacement material, capped with a loamier more friable material for a plant growth medium. This would require segregation during stripping operations and close supervision to avoid undesirable mixing of the materials; however, the end result, combined with the suitable material below the 50 or 60 inch depth in the series mentioned above, could result in 100 plus percent of premining productivity if all suitable material was recovered.

Thank you for the chance to comment.

Sincerely,

JACK O. CAMERON
District Ranger

Letter 9 Responses

1. The text has been changed to include this new information. See Chapter 2 of the regional analysis.

2. Map 7 has been revised to show many more prairie dog towns throughout the region. The Forest Service and the Thunder Basin Grazing Association provided new data for the Thunder Basin National Grasslands.

3. The text has been corrected. See Chapter 3 of the regional analysis.

4. Wildlife areas, as proposed by Shell Oil Company, would include the cooler, north-facing slopes and the drainages. Wild rose and fourwing saltbush would be used as the shrub species in these areas. The number of these areas would not be known until final reclamation plans are approved.

The Wyoming Department of Environmental Quality (DEQ), in consultation with GS, BLM, and OSM, will give final approval for all seeding mixtures and rates. Before this approval is given, the agencies will consider the surface owner's plans for postmining land use. Final approval should be consistent with the surface owner's wishes.

Sagebrush is not currently a required replacement in areas where it occurred prior to mining.

5. Wyoming DEQ regulations currently prohibit leaving ungraded highwalls (Chapter 2, Section 4.c.9 of Wyoming Land Quality Regulations, September 1978).

6. Map 5 has been corrected to more accurately delineate the riparian areas.

7. The regional maps in Appendix A have been corrected.

8. The Buckskin Mining and Reclamation Plan (May 1977) states that most post-mining slopes would not exceed 30%, in fact most slopes would be around 1%. Very short slopes may exceed 30% where disturbed areas meet steep undisturbed lands. It is recognized that these small steep areas would have a reduced productivity from the average figure cited, but it is felt that the much larger relatively flat areas would offset any productivity loss on the small steep areas.

See response 14-49 for more detail.

9. Final reclaimed slopes must meet federal and state requirements. Mulching, fertilization, and irrigation would be used where necessary and as required to establish a vegetative cover. These measures are designed to alleviate the problems of rill and gully erosion.

10. We agree that there may be suitable material for topsoiling below the 60-inch depth in the Haverson series (which is developed in alluvium) and possibly in the Olney series. Shell has stated in their mining and reclamation plan (May 1977) that they intend to put at least 18 inches of topsoil on the reclaimed site. A greater amount of topsoil could be obtained. State and federal regulations require that all available topsoil be salvaged.

See response 14-49 for more detail.

10

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
MEDICINE BOW NATIONAL FOREST
605 Skyline Drive
Laramie, Wyoming 82070

2800
Eastern Powder
River Coal

December 4, 1978

Team Leader
Coal ES Team
951 Union Blvd.
Casper, WY 82601

Dear Sir:

The following are comments concerning the Eastern Powder River Coal Environmental Statement.

1 1. Summary - Under Section 2, Brief Description of Action, the statement that 4 million tons of coal will be produced by 1985, then 4 million tons by 1990, and then 4 million tons until the end of the mine life seems confusing.

2 2. Chapter 3, page 10 - The National Grasslands are not managed in accordance with the Multiple-Use Sustained-Yield Act of 1960; they are managed under the principles of the M/U Sustained Yield Act. The correct laws for managing National Grasslands are the Resource Planning Act and the National Forest Management Act.

3 3. SU3 - Socioeconomic Conditions - Under this section, there appears to be no mention of the revenue that will be collected from royalties.

Basically, we found the report to be professionally prepared and commend you on your efforts.

Stanley Kuncl
FOR DONALD L. BOLLENS
Forest Supervisor

Letter 10 Responses

1. The summary has been rewritten.

2. The text has been corrected. See Chapter 3 of the regional analysis.

3. Mineral royalties are discussed as a potential source of revenue in Chapter 2 of the regional analysis. Mineral royalties were taken implicitly into consideration in estimating future county revenue flows. (Municipalities do not receive revenues directly from this source.) Royalties are not explicitly discussed in the socioeconomic portion of the site-specific analysis, because that section concentrates on the public finances of three municipalities--Gillette, Douglas, and Glenrock.

11

United States Department of the Interior

HERITAGE CONSERVATION AND RECREATION SERVICE
MID-CONTINENT REGION
DENVER, COLORADO 80225

IN REPLY REFER TO:
DES 78-48

MAILING ADDRESS:
Post Office Box 25387
Denver Federal Center
Denver, Colorado 80225

STREET LOCATION:
655 Miller Court
Lakewood, Colorado
Telephone 234-2634

DEC 1978

Team Leader
Coal ES Team
951 Union Boulevard
Casper, Wyoming 82601

Dear Sir:

We have reviewed the Draft Environmental Statement for the Eastern Powder River Coal Region of Wyoming in accordance with undated instructions from the Bureau of Land Management State Office, and have the following comments.

1 Page R4-29 states, "Cultural resource sites in uninventoried areas may suffer the greatest adverse effect since salvage cannot be conducted on unknown sites." This appears to be contradictory to the statement on page R3-6 that approval for mining and rights-of-way across public lands will not be given until cultural resource surveys have been done. If this is the case, ground disturbing activities should not be taking place in uninventoried areas, and damage to sites in those areas should be lessened or avoided. The Final Statement should clearly describe what activities may take place in uninventoried areas which could result in damage to cultural resources, discuss mitigation measures for such damage, and clarify this apparent contradiction.

2 While page R9-2 notes that the State of Wyoming Clearing House will coordinate the State's response, there is no definite indication that the State Historic Preservation Officer (SHPO) will be given a chance to comment. If comments are not received from the SHPO through the Wyoming State Clearing House, we recommend that such comments be requested and included in the Final Environmental Statement. The Wyoming SHPO is Ms. Jan Wilson, Director, Wyoming Recreation Commission, 604 East 25th Street, Box 309, Cheyenne, Wyoming 82001, phone (307) 777-7695.

Sincerely,

Robert J. Arkins
Robert J. Arkins
Assistant Regional Director
Land Use Coordination

Letter 11 Responses

1. The text has been revised in Chapters 3 and 4 of the regional analysis to eliminate contradictory statements. On a regional basis, 100% of the land selected for coal development has been inventoried for cultural resources prior to approval of surface disturbing activities by the federal agencies involved.

2. The comments of the Wyoming State Historic Preservation Officer have been received and are included in the final ES. (See letter 39.)

12

United States Department of the Interior
BUREAU OF RECLAMATION
Upper Missouri Region
P.O. Box 2553
Billings, Montana 59103

IN REPLY REFER TO: UM-415
120.1

DEC 7 1978

Memorandum

To: Team Leader, Coal ES Team, Bureau of Land Management, 951 Union Boulevard, Casper, Wyoming 82601

From: Regional Director, Bureau of Reclamation, Billings, Montana

Subject: Draft Environmental Statement for the Eastern Powder River Coal Region of Wyoming (DES 78-48)

The proposed development of coal resources should have no effect on projects of the Bureau of Reclamation. Thank you for the opportunity to comment on this Draft Environmental Statement.

E.R. Wills

E.R.

Letter 12

No response required.

13

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
PUBLIC HEALTH SERVICE
CENTER FOR DISEASE CONTROL
ATLANTA, GEORGIA 30333
TELEPHONE: (404) 633-3311

December 6, 1978

Team Leader
Coal ES Team
Department of the Interior
951 Union Boulevard
Casper, Wyoming 82601

Dear Sir:

We have reviewed the draft environmental statement for the Proposed Development of Coal Resources in the Eastern Powder River Basin of Wyoming. We are responding on behalf of the Public Health Service.

1 After a cursory review of the document, we were unable to determine if the water demand from the proposed projects would significantly impact on the local aquifers so as to affect public water supplies in the area. Also, we were curious to know if the affected aquifer has been designated as a sole source aquifer by the Environmental Protection Agency.

Other than the above comments, this document seems to thoroughly analyze all aspects of coal development as related to the project.

Thank you for the opportunity of reviewing this document. We would appreciate receiving a copy of the final statement when it is issued.

Sincerely yours,

Frank S. Lisella

Frank S. Lisella, Ph.D.
Chief, Environmental Affairs Group
Environmental Health Services Division
Bureau of State Services

Letter 13 Responses

1. The text in Chapter 3 of the site-specific analysis, Water Resources, has been changed to clarify the probable impact on public water supplies.

There have been no aquifers designated sole source in the Powder River Basin (personal communication, Paul Osborne, EPA, Denver 1978).

14

Shell Oil Company

Two Shell Plaza
P.O. Box 2099
Houston, Texas 77001

December 6, 1978

Coal ES Team
ATTN Ms. Julie Elfving
Team Leader
951 Union Boulevard
Casper, Wyoming 82601

Dear Ms. Elfving:

Attached are three sets of our comments on the Buckskin Mine site specific portion of the Draft Environmental Statement for the Eastern Powder River Coal Region of Wyoming. We are not offering any comments on the Regional Analysis portion of the statement.

If you would like to have further explanation of our comments, we would be pleased to discuss them with you. Also, please do not hesitate to contact us if you need additional information concerning our proposed Buckskin mining operation.

Very truly yours,

N. J. Isto

N. J. Isto
Manager Mining
Mining Ventures

Attachments

14

COMMENTS ON THE BUCKSKIN SITE SPECIFIC ANALYSIS
OF THE EASTERN POWDER RIVER BASIN COAL
DEVELOPMENT DRAFT ENVIRONMENTAL STATEMENT
Submitted By
Shell Oil Company

Comment 1
Page BU 1-1 Surface Mining Control and Reclamation Act

1 On November 12, 1978, Shell Oil Company submitted revised Mining and Reclamation Plans to the Wyoming Department of Environmental Quality, The U. S. Geological Survey, and the Office of Surface Mining. These plans meet the initial regulatory requirements of 30 CFR 700 (FR 42:62639; December 13, 1977), revised 30 CFR 211 regulations (FR 43:47181; August 22, 1978), the amended Wyoming Environmental Quality Act (1978), and revised Wyoming Department of Environmental Quality, Land Quality Division regulations (September, 1978).

The Statement is made in this section of the draft Environmental Statement (DES) that "The mining and reclamation plan cannot be approved until it conforms to all applicable Federal requirements" We believe that the revised plans submitted on November 13, 1978 conform to all applicable Federal requirements.

2 It should be noted that several of the drawings have been revised, perhaps requiring revision of corresponding figures in the DES, including Figures BU 1-4, BU 1-7, BU 1-8, BU 1-11, and BU 1-12 and Tables BU 1-1, BU 1-2, and BU 1-3. We would be pleased to provide the drawings at appropriate scale for inclusion in the DES.

Comment 2
Page BU 1-1 Proposed Action, Purpose and Objective

3 The revised plans which were submitted on November 13, 1978 show that the mine is now designed to produce approximately 1.2 million tons of coal per year for the first three years of production and expanding early in the fourth year to a production rate of approximately 6 million tons. The DES noted that 18 million tons of coal reserves had been committed. The additional customers which we have secured will require approximately 60 million tons of coal at a rate of 5 million tons per year beginning in 1984. This coal will be shipped by rail to the Gulf Coast Area.

Comment 3
Page BU 1-1 Proposed Action, Purpose and Objectives
BU 2-17 Mineral Resources
BU 5-2 Unavoidable Adverse Impacts

4 The DES states "that only 80 million tons of the 84 million tons of reserves would be extracted, because current mining technology does not permit the economic separation of the remainder from overburden and partings." This statement is not entirely correct. Approximately 1.4 million tons of the unrecovered coal will remain in the lease boundary highwalls, as depicted on Exhibit 8 of the Mining and Reclamation Plans. Further, this coal is not "lost" because it is recoverable when mining adjacent leases.

Comment 4
Page BU 1-2 Proposed Action, Location and Site Description

5 This section discusses the encroachment agreement we have with Carter Oil Company. The railroad spur is not included in this agreement. A separate agreement is being negotiated with Carter concerning the railroad. Shell Oil Company will purchase rights-of-way for both a railroad and access road.

Comment 5
Page BU 1-2 Proposed Action, Employment
BU 3-32 Socioeconomic Conditions, Economic Impacts, Employment

The DES states that "During the construction phase, Shell estimates employment at 25."

6 We recognize that the DES has concentrated on some specific years in their analysis of the proposed project. However, it is misleading to state that construction employment will be 25 persons. This number is an approximation of the average number of employees needed during the first year construction begins. As discussed in the Buckskin Environmental Analysis which was submitted to the U. S. Geological survey in July 1977, maximum construction employment is expected to be approximately 262 employees during the second year of construction. Shell intends to assist in providing housing for this construction work force.

Comment 6
Page BU 1-2 Proposed Action, Employment

7 The revised Mining and Reclamation Plans discuss a maximum production rate of approximately 6 million tons per year. When the mine reaches full production at this rate, employment will be approximately 156 persons.

Comment 7
Page BU 1-2 Proposed Action, Support Developments, Roads

8 Scoria which is exposed during the mining operation will be utilized; scoria will also probably be purchased locally.

Comment 8
Page BU 1-2 Proposed Action, Support Developments, Railroad Spur

9 The proposed Buckskin railroad spur will not connect to Carter Oil Company's spur: It will connect with the Burlington Northern Gillette North Line at about the same point where Carter's spur connects to the Gillette North Line, in Section 19, T 51 N, R 71 W.

Comment 9
Page BU 1-2 Proposed Action, Support Developments, Railroad Spur and Power Lines

10 The Buckskin railroad spur would require a right-of-way about 250 feet wide, with a maximum cut and fill width of about 800 feet, rather than the 100 feet stated in the DES. Total disturbance for the railroad will not exceed 200 acres.

Comment 10
Page BU 1-2 Proposed Action, Support Development, Railroad Spur

11 The DES states "There is a very small quantity of mineable coal under the railroad right-of-way, but the coal lessee (Carter Oil Company) does not anticipate mining any of it (personal communication, Larry Drew, Shell Oil Company, 1978)." It is true that there is a small quantity of coal under the railroad right-of-way. We do not, however, know what Carter Oil Company's mining plans are. The subject has been discussed with Carter Oil relative to our purchase of a railroad right-of-way. We have agreed that if Carter desires to mine this coal while our railroad is in place, we will move the railroad to accomodate their mining operations.

Comment 11
Page BU 1-6 Figure BU 1-4

12 This drawing shows that part of our access road crosses property not owned by Carter Oil Company. This interpretation is incorrect, as shown on the Surface Ownership Map, Appendix E-3, Application Section, Volume II, Buckskin Mining and Reclamation Plans. The access road crosses only property which is currently owned by the Carter Oil Company. We intend to purchase an access road right-of-way from Carter.

Comment 12
Page BU 1-10 Proposed Action, Coal Deposit

13 The DES states, as did our original Mining and Reclamation Plans, that the coal beds dip at approximately 3 degrees to the northwest. Our revised Plans now correctly indicate that the dip within the mine area is approximately one degree to the west and northwest.

Comment 13
Page BU 1-10 Proposed Action, Mining Sequence

14 The DES states that "The company has chosen this layout to provide for blending areas of high-sulfur coal (located in a pocket close to the facilities area) with areas of low-sulfur coal, in order to meet Environmental Protection Agency standards." The reason the coal is being blended is to meet customer requirements, so that when the coal is burned the emissions will meet EPA standards.

Comment 14
Page BU 1-10 Proposed Action, Mining Process and Procedures, Topsoil Removal

15 The DES states that "It is anticipated that approximately 500 tons of topsoil could be moved per day by one 30-yard-capacity scraper." We believe this severely underestimates the capability of a scraper. Our letter of February 1, 1978 to Mr. Newby of the U. S. Geological Survey discussed the amount of topsoil that would be moved per day. We stated that "Topsoil will be removed with one scraper operating 190 shifts per year, 78 miles per shift. Topsoil removal will average 1,414 bank cubic yards of material moved per day." Our revised plans indicate that we will utilize two scrapers; Exhibit 28 indicates the yearly volume of topsoil to be moved.

Comment 15
Page BU 1-15 Proposed Action, Mining Process and Procedures, Overburden Removal

16 The DES states that "Overburden removal would require shifting approximately 10,000 tons of material per day..." In our letter of February 1, 1978 to Mr. Newby, we stated that an average 15,054 bank cubic yards of material will be moved per day. The revised plans will require moving a greater amount of material per day, as indicated by Exhibit 28.

Comment 16
Page BU 1-15 Proposed Action, Mining Process and Procedures, Coal Mining, Loading, and Hauling

17 The DES states that "The highwall slope would be about 1:0.6." Our plans indicate that the active highwalls will have overall slopes, including roads, of 1:0.4 to 1:0.6, depending on road width.

Comment 17
Page BU 1-15 Proposed Action, Mining Process and Procedures, Coal Handling

18 The DES discusses the use of a "surge stockpile" of coal. Our approved Air Quality permit has granted us the use of a temporary stockpile of approximately 6,000 tons, to be constructed only during crushing/conveying equipment breakdowns. This stockpile will normally be in existence less than 24 hours at a time and probably less than five times per year.

Comment 18
Page BU 1-15 Proposed Action, Mining Process and Procedures, Watercourse Diversions
BU 1-16 Figure BU 1-11

19 The DES discusses the diversion of Rawhide Creek as it was presented in the original Mining and Reclamation Plans. We would like to point out that the diversion channel design has been completed, with minor modifications. The rail loop has been moved as far north as possible and culverts provided; therefore, the second diversion near the eastern boundary of the lease area, as shown on the original plans, is no longer required.

Comment 19
Page BU 1-17 Proposed Action, Reclamation Activity, Present and Future Land Use

20 It is true that we intend to reclaim the land to a primary use of grazing. We are not requesting a land use change where there are currently cultivated fields, because the disturbance to the cultivated fields will be minimal. Surface topography will change very little in the area of the cultivated fields. Topsoil will be replaced. We propose, at this time, to seed the cultivated fields with the standard reclamation mixture since we do not know what type of agricultural practices will be conducted in the area at the time when mining has been completed. The fields can readily be returned to cultivation by plowing under the vegetation established on the area. Therefore we do not believe these proposed actions constitute a land use change.

<u>Comment 20</u>
Page SU 1-17 Proposed Action, Reclmation Activity, Shaping of Overburden (Backfilling)

21 The DES states "Final shaping of the overburden would be done prior to the placement of topsoil, and would normally occur during the period when seeding of the permanent cover is impractical..." We intend to shape overburden prior to the placement of topsoil, but such shaping activities will occur throughout the year.

<u>Comment 21</u>
Page SU 1-17 Proposed Action, Reclamation Activity, Revegetation Plan

22 The DES states "Note that the impact analysis in Chapter 3, Soils, disputes Shell's statement that 100% of pre-mining productivity can be restored." This conclusion drawn in the DES assumed a minimal amount of topsoil would be salvaged and 50% of the available topsoil would be unrecovered. We disagree with these assumptions, and the conclusions, as discussed in Comment 48 below. We believe that a recovery of 80-90% of the available topsoil is more realistic for this area.

<u>Comment 22</u>
Page SU 1-20 Proposed Action, Reclamation Activity, Revegetation Plan

23 The subject of seed mixtures and the use of <u>Caragana</u> has been discussed with the Wyoming DEQ. A revised revegetation seed mixture, which excludes <u>Caragana</u> has been presented in the revised Mining and Reclamation Plans.

<u>Comment 23</u>
Page SU 1-20 Proposed Action, Pollution Control Methods

24 The fourth method discussed which would be used to prevent water pollution states that "Riprap or concrete would be used at curves in diversion ditches." The channel has been designed to provide a maximum flow velocity of two feet per second. This flow rate would not be erosive on the channel as designed. However, <u>if it becomes necessary</u>, riprap or concrete will be utilized to prevent erosion.

<u>Comment 24</u>
Page SU 1-20 Proposed Action, Pollution Control Methods

25 The DES states that "At present, no data is available as to the presence or absence of toxic materials at the Buckskin lease...." We have supplied a considerable amount of overburden analyses, which are contained in the Mining and Reclamation Plans. We do not anticipate any problems due to toxic materials. This subject is further discussed in the revised plans.

<u>Comment 25</u>
Page SU 1-20 Proposed Action, Pollution Control Methods

26 The DES states that "Combustible material uncovered during mining would be buried or stored in waste piles stabilized with layers of incombustible and impervious material." We do not fully understand this statement. Coal is a combustible material. We will be removing this product from the area. Refuse materials, as described in the Mining and Reclamation Plans, would be buried. Further, solid waste will be buried according to the requirements of the Wyoming Department of Environmental Quality.

<u>Comment 26</u>
Page SU 1-20 Authorizing Actions, Office of Surface Mining (OSM)

27 The DES states "OSM, with the concurrence of the surface-management agency (Bureau of Land Management) and USGS, recommends approval or disapproval of the Mining and Reclamtion Plan..." We believe it should be pointed out that all surface involved is privately owned. Therefore, we interpret that the Bureau of Land Management is not involved in the approval/disapproval process (30 CFR 211.3(a)(3); FR 43:37181; August 22, 1978).

<u>Comment 27</u>
Page SU 1-23 Authorizing Actions, Bureau of Land Mangement (BLM)

28 We do not understand BLM's role in the development of "special requirements" and the granting of rights-of-way concerning the proposed Buckskin Mine. All lands involved are private lands. Specific authorities regarding the protection of "all resources, other than coal and the post-mining use of the affected lands" should be clarified. Some of the resources other than coal are also privately owned.

<u>Comment 28</u>
Page SU 2-3 Geology

29 The DES states that "Scoria (clinker) is present in many places where the coal seam is exposed..." There are no known places on the mineral lease where the coal seam is exposed. Scoria is the result of past fires; it may be present in places where the coal seam has never been exposed. We suggest substituting the following language: <u>Scoria (clinker) is present in several places in the proposed permit area.</u>

<u>Comment 29</u>
Page SU 2-6 Figure SU 2-4

30 This figure shows an interpretation of the top and base of the coal, and says that this was interpreted from Shell Oil Company. We have supplied no information from which these interpretations can be made. In fact, several of the maps contained within the Mining and Reclamation Plans show an erosional/burn limit of the coal which does not correspond to the interpretations on Figure SU 2-4. We disagree with the interpretations on Figure SU 2-4.

<u>Comment 30</u>
Page SU 2-8 Water Resources

31 The DES indicates that water analyses are contained in the Appendix. None are present.

<u>Comment 31</u>
Page SU 2-12 Water Resources, Surface Water

32 The DES states that "water is presently used on the mine site for stock and wildlife watering and for irrigation of hay and grain fields." No water is being used for irrigation of grain fields and the irrigation of hay fields is by flood irrigation which occurs in the spring of the year.

<u>Comment 32</u>
Page SU 2-12 Vegetation

33 The DES states that "the proposed Buckskin Mine site, in particular is more representative of true shortgrass plains than the surrounding areas." We disagree with this statement. It is true that there are several species present which are characteristic of the shortgrass plains. However, over most of the proposed mine area, sagebrush is a dominant feature. The implication should not be made that this area is a unique inclusion of shortgrass within a transition zone. The species cover data support this conclusion.

<u>Comment 33</u>
Page SU 2-12 Vegetation, Terrestrial Vegetation

34 The statement is made that "The vegetation map, however, is confined to the main mining area..." Vegetation maps were supplied which cover the entire permit area.

<u>Comment 34</u>
Page SU 2-13 Vegetation, Terrestrial Vegetation, Riparian Type, Cultivated Lands

35 The DES states that "The vegetation of Rawhide Creek is indicative of an alluvial valley floor." We disagree with this statement. The vegetation present is indicative of the presence of subirrigation of plant roots, which is only one of the several criteria used in determining the presence or absence of an alluvial valley floor. The DES indicates that there are about 169 acres of cultivated lands within the proposed permit area. It should be noted that for the most part this cultivation consisted of seeding to desirable native and introduced grasses in a range improvement program.

<u>Comment 35</u>
Page SU 2-13 Vegetation, Aquatic Vegetation

36 The DES states "Aquatic vegetation is limited to species which require wet ground, but which can exist for long periods without standing water, as in valleys with subirrigated alluvium." We do not believe this to be an unbiased statement. Several other moisture conditions without standing water may support aquatic vegetation, including subirrigated colluvium, subsurface springs, overflowing water tanks and leaky pipes.

<u>Comment 36</u>
Page SU 2-14 Figure SU 2-8

37 The color codings for riparian and cultivated lands are reversed. It should be noted that several of the areas identified as cultivated have only been seeded to native or introduced grasses as range improvement or for hay production. Exhibits 36 and 37 identify these areas. The areas identified as riparian are much broader and extensive than actually exist on the area. One area in the northwest corner of the proposed permit area is misidentified as playa; it should be the cultivated type.

<u>Comment 37</u>
Page SU 2-15 Fish and Wildlife, Fishery

38 The DES states that "These stagnant pools do not contain any fish." During the late summer of 1978 the Wyoming Fish and Game observed some fat-head minnows in a pool at the east edge of the permit area.

<u>Comment 38</u>
Page SU 2-16 Fish and Wildlife, Amphibians and Reptiles

39 "A plains garter snake was the only reptile observed on the site." A snapping turtle was also observed on the site, as reported in the Mining and Reclamation Plans.

Comment 39
Page SU 2-16 Cultural Resources, Prehistoric

40 The revised Mining and Reclamation Plans show a slightly altered railroad alignment. Prehistoric site 48 CA 130, an arroyo trap bison kill site, is no longer within the proposed railroad right-of-way.

Comment 40
Page SU 2-24 and 25 Tables SU 2-3 and SU 2-4.

41 These tables show employment in the "Minerals" category, which we assume contain employment for the petroleum industry. The discussion of employment in the "minerals" sector refers to mining employees (page SU 2-22 and others) and mining employment. It was our understanding that at least up to this year, there was more employment in the petroleum sector than the mining sector in the Gillette area. We believe this fact should be addressed.

Comment 41
Page SU 3-7 Air Quality, Impact on Air Quality

42 The DES states that "Climatological data were collected at the Moorcroft weather station, because the weather station at Gillette had insufficient data." It was our understanding that the Moorcroft data were for the period 1950-1952 and was utilized because atmospheric stability data were available.

Comment 42
Page SU 3-7 Topography

43 The DES states "Some revision in design may be necessary to meet Office of Surface Mining requirements for keeping reclaimed topography in concert with contiguous operations." We are not sure what is meant by this statement. As our Mining and Reclamation Plans show, reclamation is being carried out as expeditiously as possible. Reclamation is delayed on a limited area for years 5 to 9 due to the presence of an overburden stockpile on this backfill area. We believe it is better to construct this stockpile on disturbed area rather than to disturb new areas. The Mining and Reclamation Plans show that reclamation will be conducted as rapidly as possible for the restricted area in which the operation will be conducted. The revised plans show that beginning in Year 4, when there is space first available, final reclamation activities are conducted continuously (Exhibits 26 and 27 of the Plans).

Comment 43
Page SU 3-17 Geology
SU 4-17 SMCRA Performance Standards, Protection of the Hydrological system.

44 The DES states that "About 1-1/2 miles of alluvial valley floor, as defined by the Surface Mining Control and Reclamation Act, would be disturbed..." The Surface Mining Act requires special consideration be given to areas designated as alluvial valley floors. Detailed regulations have been written concerning the subject, and a guideline outlining the study requirements necessary for determination of the presence or absence of an alluvial valley floor has been prepared by the Office of Surface Mining. We therefore object to wording, such as that above, which indicates an alluvial valley floor is present on the mining area. To our knowledge, a determination based on the data requirements of the regulations and guideline has not been made. We recognize that an intermittent stream occurs on the proposed permit area and that along a part of the stream haying activities have been conducted. However, the portion of the stream which occurs within the area to be mined is undeveloped rangeland which in itself is not significant to the ranching operations. Mining this portion of the stream channel would be a negligible impact on the production of the farm. Therefore, even if the entire stream were to be determined to be an alluvial valley floor, that portion within the area to be mined would not meet the criteria of the Surface Mining Act which would require it to be excluded from mining. Geologic studies indicate that Spring Draw is an alluvial fan, which is in itself excluded from alluvial valley floors. Further, we believe we have designed Mining and Reclamation Plans that will maintain the hydrologic integrity of the stream. During mining, the stream will be rerouted to maintain downstream uses. Following mining the stream will be replaced in its approximate original location with its same length and gradient.

Comment 44
Page SU 3-17 Soils

45 The DES indicates that based on some research work that current levels of soil productivity would be lost and not fully recovered. We are not aware of any studies which have shown long term losses in productivity. We agree that some studies have shown short term reductions in productivity, but others have also shown short term increases in nutrient availabilty from stockpiled topsoil. We believe that even with topsoil stockpiling, which would be required under any mining scheme, the post-mining productivity of the area will equal or exceed pre-mining productivity since approximately 40 inches of suitable topsoil will be salvaged and replaced over the disturbed area. A substantial portion of the area which will be disturbed has little or no suitable topsoil today; the productivity of these areas will certainly be increased. Further, only about half of the salvaged topsoil will be stockpiled, and of the material stockpiled a substantial portion of that will be at or near the surface of the stockpiles thus maintaining the soil microflora and microfauna.

Comment 45
Page SU 3-17 Soils

46 The DES states that "According to drilling logs," materials harmful to plants and animals "are absent or present in very low amounts". The extensive overburden analyses which have been conducted also show this to be true.

Comment 46
Page SU 3-17 Soils

47 The DES discusses increases in erosion of soil due to the proposed mining operation, and suggests increases of 400-500% for wind erosion and 100-500% increases for water erosion. We believe that these numbers are unrealistic based on the extensive mulching program, temporary revegetation, and special practices (where necessary) which we have detailed in the Mining and Reclamation Plans. It should also be pointed out that the annual losses which are suggested in the DES are short-term and not long-term.

Comment 47
Page SU 3-18 Soils

48 We disagree with the statement that "The limited amount of good to fair soil material, moderately steep slopes, and soils that are poor for reclamation are evident on the Buckskin project in a number of mapping units." On the contrary, there are a number of soils which are suitable for use in reclamation; approximately 33 inches of good to fair topsoil are available for salvage and approximately 7 inches of poor quality (but not unsuitable according to Wyoming DEQ criteria) topsoil are available for salvage over the entire disturbed area.

To continue, the DES indicates that there is going to be "reduction in soil productivity on major portions of the distrubed acreage". Again, we submit that approximately 40 inches of topsoil is more than adequate to maintain the productivity of rangeland, hayland, and dry land row crops. We further submit that our soil analyses show that the topsoil is available and of suitable quality.

Comment 48
Page SU 3-18 Soils
SU 4-4 Table SU 4-1
SU 4-17 SMCRA Performance Standards, Topsoil Handling
SU 5-12 Unavoidable Adverse Impacts.

49 The DES presents a discussion concerning a 13 percent loss in soil productivity. We disagree with the assumptions made in this interpretation. As pointed out on page SU 4-1 of the DES, the methodology has not been verified on mined lands. Our calculations show that about 3,665 acre-feet of topsoil will be salvaged, rather than the 3,117 used in the DES. The DES assumes that only half this material is recoverable and further indicates that this is the usual result. We believe that a much higher recovery rate is normal and will be accomplished. Secondly, the site productivities utilized in Table SU 3-8 for the determination of total production do not agree with actual productivities measured, resulting in a substantial overestimate of the pre-mining production. For example, the Big Sagebrush type covers about 40 percent of the proposed mine area, occurs primarily on clayey soils, and produced about 635 pounds per acre, (compared to 1300 lb/A in the DES) in a better than average moisture year (1977). To make a site specific determination that production will not be at least 90% of pre-mining production, we believe that site specific data should be used.

The DES concludes that "there would probably be a long decline in productivity in later decades as the vigor of the planted species declines on the overall thinner soil than existed prior to mining. There are no long-term studies which support the supposition of a long-term decline in plant vigor. Further, although some portions of the disturbed area will have soils thinner than exist today, portions of the disturbed area will have thicker soils than exist today. We believe that the approximate 40 inches of topsoil to be salvaged is more than adequate for the range/hay/dry land crop production for which the land will be reclaimed. To quote the DES, "If a greater depth of "topsoil" material were replaced, such as 30 inches, along with the appropriate soil amendments, the long-term productivity of the site should equal or exceed the pre-mining productivity."

Comment 49
Page SU 3-18 Water Resources, Ground Water.

50 The water required is 50 gallons per minute, not 5 gallons per minute.

Comment 50
Page SU 3-23 Water Resources, Surface Water

51 The DES discusses the probability of a flood in excess of 1,000 cfs and the possibility of overtopping the bypass channel. The revised Mining and Reclamation Plans show in detail the methods by which a 100-year, 24-hour storm will be controlled during the mining operation. The diversion and stream control facilities have been designed to handle the run-off from a 100-year, 24-hour storm without "overtopping". Further, run-off from distrubed lands for the 10-year, 24-hour storm be contained in sedimentation ponds. At those times when the above storms are exceeded, the additional sediment added to the flow of Rawhide Creek from disturbed areas would be very minor.

Comment 51
Page BU 3-23 Water Resources, Surface Water
BU 3-31 Agriculture, Livestock Production
BU 7-1 Irreversible and Irretrievable committments

52 The DES indicates that the lowering of the water table following mining will eliminate or discourage grazing, and therefore the land would not be returned to its pre-mining productivity. We have said we believe that the water table will reestablish itself several feet below the ground surface and that the water table would probably be intercepted by the materials in the replaced stream channel. We have also indicated that we plan to reestablish an existing impoundment in the area. We firmly believe that there will therefore be sufficient water available for the post-mining land uses.

Comment 52
Page BU 3-23, 24 Water Resources, Surface Water
BU 3-24 Vegetation, Terrestrial Vegetation
BU 3-31 Agriculture, Livestock Production
BU 4-1 SMCRA Performance Standards, Backfilling and Grading — Thin Overburden
BU 4-8 Table BU 4-1
BU 5-1 Unavoidable Adverse Impacts.

The Draft Environmental Statement discusses the possibility of the creation of a surface water impoundment along Rawhide Creek if overburden settling occurs. The discussion states that settlements of between 3 feet and 10% or 20% of the backfilled overburden could occur after mining and reclamation is complete, thus producing water impoundments ranging from 35 acres to about 240 acres.

53 We do not believe such settlements will occur after mining and reclamation is complete. The three foot settlement figure furnished by us was intended to represent what we think is going to be the maximum amount of settlement of the backfilled overburden (spoil). We believe that most of the settlement will occur shortly after the overburden is backfilled with almost complete settlement occuring within a few years. Therefore, we believe that most of the settlement will occur prior to completion of reclamation activities.

We plan to backfill to approximately the final contour elevation as we advance mining, except for Years 4 through 8 where an overburden stockpile will be created on top of the spoil. Figure 1 (attached) illustrates the backfill schedule for the Buckskin Mine. Mining will take place during Years 1 through 16. Final backfilling and completion of reclamation will take place in Year 17. It can be seen from Figure 1 that Rawhide Creek will be located on areas backfilled in Years 3 through 10. Therefore Rawhide Creek will be located in an area that has been backfilled from at least 7 to 14 years prior to completion of reclamation in Year 17. Our Mining and Reclamation plans indicate that Rawhide Creek

will not be returned to the backfilled overburden area until at least two years after the overburden has been replaced (approximately Year 12 or 13). We believe that any settlement which might occur after Rawhide Creek has been returned to the backfilled area will be localized and will most certainly occur prior to completion of reclamation in Year 17. However, we believe that little if any settlement will occur once the material underlying Rawhide Creek is infiltrated with water. Water within the voids of the overburden will effectively stop settlement. This will be true of most of the overburden below the ground water level.

As we stated above we believe that the maximum amount of settlement of the overburden will be approximately 3 feet and with most of this settlement occuring prior to completion of reclamation. However, the assumption that the reclaimed topography will settle 10 to 20% after completion of mining and reclamation is unrealistic. The average depth of the spoil is 148 feet. (This figure is obtained by taking the difference between the average elevation of the final topography and the average elevation of the mine pit bottom.) The 10% and 20% settlement would represent elevation drops of 14.8 and 29.6 ft. respectively.
53 Terraghi and Peck (1967 p. 270)* have stated that settlement depends only on the physical properties of the soft strata and on the intensity and distribution of the vertical pressure on these strata. Considering that the average thickness of the spoil is 148 ft., the overburden at the bottom of the pit is under considerable ground pressure, in excess of 80 lb/in^2, due to the natural weight of the overlying material. Therefore this overburden will settle rapidly. Overburden backfill that will not benefit from this effect is the surface material. This zone of overburden is relatively thin. If settlement occurred after reclamation it would occur in this zone. The depth of this zone is difficult to determine. Even in the event that this zone is 10 to 20 ft. in depth, the corresponding 10 to 20% settlement would only amount to 1 to 4 ft.

Most of the settlement of the overburden will be produced by the weight of the overlying material. However, other activities will also produce settlement. The mining operation is to be by truck and shovel, resulting in a more compact overburden than normally experienced with dragline spoils. As mentioned above, settlement of an area depends on the soft strata, such as clay materials, in which settlements are time dependent. However, due to the mining operations, clay type materials which are generally found in layers will be redeposited in the spoil mixed with rock and other noncompressible materials. This will decrease greatly the settling action of the soft materials.

*Terzaghi, K. and R. B. Peck. 1967. Soil Mechanics in Engineering Practice. John Wiley and Sons, Inc., New York. 729p.

In our original Mining and Reclamation Plans we used a swell factor (bulking) of 25%. This figure represents the "permanent" swell figure, which includes settlement. Since that time we have revised our permanent swell figure to 20% to represent more closely rock conditions being encountered in the Powder River Basin. For supporting evidence we cite the text of Engineering Geology which indicate that the normal range is 20 to 30% rock materials (this material supplied to the ES Team on December 12, 1977). Therefore we are predicting that while the transient swelling of the overburden may vary between 30 to 50% the permanent swell will be approximately 20% which will include settlement. The final topography has been designed for a 20% swell for the overburden. This includes 0% swell for the topsoil which will be placed on top of the
53 overburden. Therefore if total settlement does not occur until after completion of reclamation the topography should be higher than the designed final topography. After settlement is complete the final topography should approximate the designed topography.

To help quantify the swell and possible settlement of the Buckskin Mine overburden the stockpiles created prior to mining will be observed. An overburden stockpile, located in the southern perimeter, will be created one year prior to mining, left undistrubed until the last couple years of mining and then backfilled into the final pit. This stockpile will be approximately 100 ft. in height. Any settlement that occurs in this stockpile will show up in the 17 years during its existence. We should then be able to design for settlement that will take place after mining by observing the reaction of the overburden stockpile.

Comment 53
Page BU 3-24 Vegetation, Terrestrial Vegetation

We refer to Comment 48 relative to the stated 13% long-term loss in productivity. We also disagree with the 80 to 85 percent loss in wildlife habitat. We recognize that for a particular species there may
54 be habitat loss; for other species there will be habitat improvement. We have also stated in our Mining and Reclamation Plans that we will be replanting some shrub and forb species. Major wildlife which utilize sagebrush, the major shrub present, will not be adversely affected. No sage grouse are present on the area; the proposed mine area is only a small part of the home range of the antelope present.

Comment 54
Page BU 3-27 Fish and Wildlife, General Information
BU 5-2 Unavoidable Adverse Impacts

The DES mentions "121 acres of cultivated land" would be
55 disturbed. The majority of the cultivated land is land that has undergone range improvement by the seeding of native and introduced grasses.

Comment 55
Page BU 3-27 Fish and Wildlife, Wildlife, Mammals

The DES discusses fencing along the railroad, mine area and access road forming a barrier to antelope movement. This assumes the use of a woven wire fence or a barbed wire fence with low barbed strands. We have indicated we would use fencing as recommended by the Wyoming DEQ
56 which would allow antelope movement, except in those very limited areas where further restriction is necessary for safety reasons. A three or four strand barbed wire fence, bottom wire smooth and an appropriate distance above the ground will be used for most of the access and railroad fencing.

Comment 56
Page BU 3-28 Table BU 3-12

This table indicates that the impacts on fish and wildlife will be major and that the impacts on the carrying capacity for fish and wildlife will be major. Yet the table shows that the impacts on fishery populations will be none; will be minor or none on bird populations; will be minor on non-game mammals, no impact on endangered mammals, and major on game mammals; and will be major on amphibians and reptiles with no impact on endangered reptiles and amphibians. There are very few reptiles and amphibians present on the area. Snakes will certainly reestablish themselves in the reclaimed area; in all probability frogs will reinhabit the replaced impoundment. Of the game mammals, three species are present: cottontail rabbit, antelope and mule deer. Mule deer are practically
57 non-existent on the area, the area being only a small part of the range of a limited amount of deer in the vicinity. Cottontail rabbits will reestablish themselves in the area; forage will be available and cover from shrub plantings will be available. Finally, the mining area is only a small part of the range of the antelope in the vicinity. Therefore we cannot agree that there will be major long-term impacts on wildlife populations. We firmly believe that in the long-term populations will not be significantly affected due to the proposed project; the small amount of the disturbed area, less than 1100 acres, limits the impact. We also believe that in the long-term carrying capacity and wildlife habitat will not be significantly affected, due to the reestablishment of forb and shrub species through plantings and natural invasion.

Comment 57
Page BU 3-29 Table BU 3-13

This table presents a biased view of the impacts on wildlife. There is no presentation of habitat reclaimed. Some of the individuals
58 displaced during mining will move into reclaimed areas, and therefore would not be "lost". For example, doves (a migratory bird) will probably find the reclaimed areas to be better habitat than the pre-mining vegetation.

Comment 58
Page SU 3-30 Recreation Resources

59 We cannot agree with the conclusion that "although the population increase attributable to Buckskin would be minor (5%) compared to overall population growth in Campbell County by 1990, its impact would be significant." The significant impacts on recreation resources will be due to the cumulative growth in the county from all development. A small increase in population would, in itself, not cause major impacts on recreation resources.

Comment 59
Page SU 3-31 Agriculture, Livestock Production

60 The DES indictates that "Once the Buckskin and other mining operations commence, the operators expect to go out of the grazing business completely in the area". It is our understanding that the ranchers, who are currently leasing the proposed mining areas for agricultural purposes, expect to continue their operations while mining progresses. The ranchers understand, however, that some land will be unavailable during mining and early reclamation.

Comment 60
Page SU 3-31 Transportation Networks, Railroads

61 The DES indicates that the railroad spur serving the Buckskin Mine would cause crossing hazards. Highway 59 is currently being relocated and a grade separation crossing is being constructed. Only private roads will be intersected by the rail spur.

Comment 61
Page SU 3-32 Transportation Networks, Highways, Other

62 Under "Highways" it is stated that the peak mine-related population increase would be 843. Under "Other" it is stated that the peak mine-related population increase would be 730.

Comment 62
Page SU 3-32 Socioeconomic Conditions, Economic Impacts, Population

63 Under the revised Mining and Reclamation Plans, we anticipate that our maximum permanent employment will be 156 persons. This level of employment will be reached in 1984.

Comment 63
Page SU 3-34 Socioeconomic Conditions, Economic Impacts, Income

64 It is stated that "In 1990, direct, indirect, and induced earnings attributable to Buckskin would be $14.2 million including railroad earnings." This estimate appears to be low, if it does include railroad earnings. If transportation is only $5 per ton of coal, and 6 million tons of coal are shipped, the income to the railroad would be $30 million.

Comment 64
Page SU 4-1 SMCRA Performance Standards, Postmining Use of Land

65 The DES states "Presently, 121 acres of the Buckskin site are, or have been in the past, used as cropland." Most of the area identified as cropland is essentially improved rangeland, seeded to native or introduced species.

Comment 65
Page SU 4-17 SMCRA Performance Standards, Topsoil Handling
SU 5-2 Unavoidable Adverse Impacts

66 The DES indicates that "Accidental spillage of oil, gas, or other toxic materials would contaminate soil and render it useless for reclamation." It should be pointed out that this is a very remote possibility, since topsoil will be segregated. If such an accident did occur it would only contaminate a very small amount of material since large volumes of oil, gas, etc. are not being handled in areas of topsoil.

Comment 66
Page SU 4-20 Committed Measures

67 Our discussions with the Wyoming State Engineer's Office have not indicated that the temporary diversion facilities must be designed to accommodate back-to-back 100-year, 24-hour storms. Our design shows accommodation for a single 100-year, 24-hour storm; it is our understanding that such a design will meet the State Engineer's Office requirements.

Comment 67
Page SU 5-2 Unavoidable Adverse Impacts

68 The DES states that "Two cultural resource sites would be destroyed...". We believe this statement should be clarified that these sites were minor and archaeological clearance was granted.

Comment 68
Page SU 8-1 No-Action Alternative

69 The no-action alternative would not result in 1071 acres being undisturbed. A portion of this land is within the boundaries of another permitted mine.

Comment 69
Page SU 8-2 Alternative to Approve Mining and Reclamation Plan After Modification, Coal Transport by Conveyor Belt.

70 We do not believe this method of transport is feasible on this project. The grade that would be required for a conveyor would require additional land disturbance and delay reclamation. Costs for the system, if required, would render the project unfeasible.

Comment 70
Page SU 8-2 Alternative to Approve Mining and Reclamation Plan After Modification, Fish and Wildlife Mitigation Alternatives.

71 We believe that the goal, as proposed in the DES, for reclaiming to the highest possible wildlife carrying capacity would be a land use change not acceptable in an agrarian region. We are required to reclaim the land to the highest previous uses, which in the Buckskin are ranching activities.

Letter 14 Responses

1. The revision of the Buckskin mining and reclamation plan (M&RP) will not significantly change the regional cumulative impacts because projected coal production from the region is substantially greater than that from the Buckskin Mine alone.

Preparation of the Buckskin site-specific analysis was begun with the understanding that further environmental analysis might be necessary when an acceptable M&RP is finally submitted. This is still true. The revised M&RP will be reviewed, and if found acceptable, an environmental analysis will be made to determine whether impacts are covered in this ES.

2. The figures and tables in the ES correspond to those in the May 1977 M&RP, the one used for the site-specific analysis. Hence they have not been changed.

3. As explained in Chapter 1 of the site-specific analysis, the revised M&RP must be evaluated and accepted by the Office of Surface Mining as meeting requirements of the State and the Surface Mining Control and Reclamation Act before any environmental impacts caused by M&RP modifications will be assessed.

4. Relevant parts of the text have been corrected in Chapters 1, 2, 3, 5, 6, and 7 of the site-specific analysis.

5. The text has been revised.

6. The text has been revised to state that maximum construction employment would be 262. Average construction employment in 1980 (197) was used in the final ES to calculate population growth and employment attributable to Buckskin.

7. Please refer to response 14-3.

8. The text has been revised.

9. The text has been revised.

10. This comment provides new information inconsistent with Shell's M&RP (May 1977). The reclamation schedule in that document shows that a total of 1,071 acres would be disturbed for the mine, the railroad, the rail loop, the access road, and all ancillary facilities. Increasing the width of the railroad right-of-way by 150 feet would increase disturbance by approximately 110 acres (see Tables SU1-2 and SU3-3).

Please see response 14-3.

11. The text has been revised.

12. Figure SU1-4 has been revised.

13. This new information about the geology at the mine site has been incorporated in the site-specific analysis, Chapter 1.

14. The text has been amended.

15. The text has been corrected, using a conversion factor of 2,750 pounds per bank cubic yard of soil material.

Please see response 14-3.

16. The text has been corrected, using a conversion factor of 3,437 pounds per bank cubic yard of overburden. (GS estimates the overburden in the area to be about 15% hard rock (mostly sandstone), 51% sand, and 34% clay.)

Please see response 14-3.

17. The text has been revised.

18. The text has been amended.

19. Please see response 14-3.

20. When cultivated land is reclaimed for livestock grazing use, this constitutes a land use change. If it is reclaimed to cultivated use, this does not constitute a land use change. Any proposed change in use must conform with state and federal regulations.

21. Our statement in the ES was derived from Volume I, Reclamation Plan, page 9, of Shell's M&RP (May 1977).

22. See response 14-49.

23. Please see response 14-3.

24. The text has been amended.

25. The sentence in question has been deleted.

26. The item in question has been deleted.

27. The text has been changed to read "leasing agency." As the leasing agency, BLM is responsible for insuring that surface mining is conducted in a manner to minimize impacts to the natural and cultural resources of the area.

28. The reference to rights-of-way is, in this case, irrelevant, since no federal surface is involved. It has been deleted. However, where federal minerals occur with private surface, BLM is properly concerned with the impacts, both on and offsite, resulting from the mining and transportation of federal coal.

29. The text has been revised. See Chapter 2 of the site-specific analysis, Geology.

30. The map has been revised. See Chapter 2 of the site-specific analysis, Geology, and Figure BU2-4.

31. The water analysis tables have been included in the final ES.

32. The reference to grain fields has been deleted.

33. In a transition zone between two vegetative types, it is not unusual to find areas that are more representative of one type than the other. In this case, the Buckskin Mine site is more representative of the short grass plains.

This statement is based on information submitted by Mine Reclamation Consultants (Shell 1977) and confirmed by on-the-ground checks. This does not make the site unique. If it were not in a transition zone, then it would be unique.

34. In the interest of trying to keep the ES less voluminous, it was decided to limit the vegetation, soils, and geology maps to the main mining area.

35. One of the criteria for determining the presence or absence of an alluvial valley floor is the vegetative composition found there. From the information submitted by Mine Reclamation Consultants (Shell 1977) and confirmed by on-the-ground checks, it appears that Rawhide Creek has vegetation which is commonly found in alluvial valleys.

Information submitted by Mine Reclamation Consultants (Shell 1977) indicates that 121 acres of the Buckskin site are or have been used as cropland. The figure is broken down as follows: 32 acres of barley, 2 acres of wheat, and 87 acres of hay. The fact that several of the cultivated areas are improved rangeland seeded to native or introduced species has been noted in the text, Chapter 2 of the site-specific analysis, Vegetation.

36. The text has been reworded.

37. The color coding and stiplings on the map have been corrected. The riparian designation used is a broad one which includes bottomland. The map legend has been changed to read "Riparian-Bottomland." The text has been revised to clarify the type of cultivation which has occurred on the mine site.

38. The text has been revised to include this new information.

39. The text has been revised to include the snapping turtle as a species observed onsite.

40. Site 48 CA 130 has been identified as eligible for nomination to the National Register of Historic Places (Zeimens et al. 1978). Because of this, any possible impacts to the site must still be considered by the Bureau of Land Management, Wyoming State Historic Preservation Officer, and the Advisory Council on Historic Preservation, to satisfy the National Historic Preservation Act, the National Environmental Policy Act, and Executive Order 11593.

41. In order to maintain consistency in the data source throughout the ES, the U.S. Department of Commerce, Bureau of Economic Analysis (BEA) (1977) was used. This creates some problems for discussion of a rapidly growing city such as Gillette, in that the most recent information available is from 1975. There is also some confusion due to the sectoral breakdown and comparison between BEA data for employment and earnings. In the case of employment, the minerals sector includes employment for the petroleum industry and is therefore representative of all minerals employment. For the purpose of illustrating general employment trends, this is sufficient. The narrative provides additional information regarding the actual origin of the growth (mining and construction).

42. The Moorcroft weather station data was used because a STAR data deck, necessary for modeling programs, was available, whereas the data from the Gillette weather station did not have a STAR data deck already compiled.

The text has been revised to clarify this point.

43. The sentence in question has been deleted.

44. According to Van Williams, Surficial Geologic Map of the Rawhide School Quadrangle, Campbell County, Wyoming, Geological Survey MF 978, 1978, the map unit Qfa as shown on Figure BU2-4 is within the definition of alluvial valley floor (Surface Mining Control and Reclamation Act 1977).

45. See response 14-49. The Buckskin Mine M&RP (May 1977), Volume I, Reclamation Plan, page 7, states that productivity of reclaimed stands in the Northern Great Plains declines from initial levels.

46. The text has been revised.

47. We do not believe that our figures for wind and water erosion are unrealistic. In fact, if severe climatic conditions (e.g., drought, very high winds, or flooding) should coincide with the reclamation effort, soil losses could be even greater.

These soil losses would occur over a short period of time (during reclamation); however, soil loss from the mine site is irretrievable and therefore long term.

48. See response 14-49.

49. The methodology used in this document concerns itself with the long-term land capability and forage production potential based on the soils resource on the site. This is explained in the document. We do not agree or disagree with the statement by Shell that the clayey soils on the site are producing, at present, 635 pounds per acre of forage. Based on studies by the Soil Conservation Service, clayey sites have the potential to average 1,300 pounds of air-dry forage per year in northeastern Wyoming. This long-term capability of the soils resource is our concern. We disagree with Shell that 3,665 acre-feet of topsoil would be recovered, but we do agree with them that our recovery rate was conservative and have, upon further analysis, revised our figures to show a greater amount of topsoil recovery than we had originally shown. (See revised soils tables in Chapter 3 of the site-specific analysis.)

There are studies which support our statement that there would probably be a long-term decline in plant vigor on the reclaimed sites; the latest work that we know is by Brian Sindelar, Assistant Professor, Montana State University, Bozeman, Montana, and is reported in Rangeman's Journal, August 1978.

We disagree that 40 inches of topsoil can be salvaged (again, see revised soils tables).

We certainly acknowledge that our methodology has not yet been verified on mined lands, but we feel that is only because of its recent application and adaptation to mined lands. We believe that it will prove to be our most valuable tool to date to consistently evaluate long-term impacts from mining on our soils resource.

50. Shell Oil stated in a letter dated December 20, 1977, that 4,655 gallons of potable water would be required per day at Buckskin. This is equivalent to 3.23 gallons per minute, or less than 5 gallons per minute, as was stated.

51. Whenever an offstream hydraulic structure (the size of those needed for interception of Spring Draw drainage) is breached, the resulting slug of water picks up a volume of sediment which is considerable, even in the much larger Rawhide Creek. About 80% or 90% of the sediment carried by streams in the region comes during the few major flow peaks each year; and this occurs in well defined and protected natural channels. (Any breach of structure would occur most likely during one of these major flow peaks.) Also, see response 14-3.

52. The ES states that grazing would be discouraged as the result of loss of watering points. If the water table occurs below the replaced stream bed, these watering sources would be lost; if above, they would be replaced. The estimate of environmental conditions is given in the text, if a water impoundment is intercepted by the groundwater table. If an impoundment does not intercept groundwater but only surface runoff, then the impoundment might be considered as a replacement for the lost watering sources. Surface water impoundments, however, normally do not hold water for periods as long as do groundwater-fed impoundments, and, as a result, are considered inferior to groundwater-fed ponds (as long as chemical quality of the water is the same in both surface water and groundwater-fed ponds).

The ES indicates that, as a mitigating measure, restoration of reservoirs will be required. This should insure adequate livestock water. The ES does point out the consequences of the loss of watering sources in order to emphasize the need for the mitigating measure.

53. The area covered by the estimated depression due to settlement, as determined from the postmining topography, would be north of the indicated overburden stockpile and west of the unmined, railroad loop area, not along the replaced Rawhide Creek channel. This channel would be within a couple of hundred yards of the probable depression, and flood flows would most likely break into this depression. The depression would intercept all flow from the Spring Draw drainage. (The depression could also be filled by the groundwater which has been predicted by Shell Oil to be within several feet of the land surface.)

It is conceded that settlement would materially slow or possibly stop when the material under Rawhide Creek becomes saturated by groundwater.

The discussion in Terzaghi and Peck you use to support your argument relative to the 10% and 20% settlement values, refers to undisturbed soils, not excavated soil.

It is conceded that most of the settlement of the replaced overburden would be attributable to the weight of the overlying material; but information from consultants (licensed professional engineers and a professional geologist) involved with the placement of excavated soils, indicates that consolidation by trucks is not effective when material is placed in lifts thicker than several feet.

It seems unlikely that the overburden could be classed as either "rocks" or "soils with rock fragments" in Table 8.1 (Engineering Geology). One Geological Survey mining engineer familiar with soils and rocks in the vicinity of the Buckskin Mine site stated that the overburden should more realistically be classed as "clayey, sandy soil." (This classification could indicate settlement, difference between transient and permanent bulking, of 12% to 23%.) Nothing was noted in the mine plan that would indicate that backfill would be placed at a higher elevation than the final contours, so as to allow for settlement.

The plan to help quantify swell and settlement appears reasonable.

All references to the 240-acre depression due to 10% to 20% settlement at Buckskin Mine has been deleted from the ES.

54. Pronghorn, sage grouse, and sharp-tailed grouse all would be adversely affected by the loss of sagebrush. Mourning doves currently are more abundant in the sagebrush and riparian vegetation types on the site than in the sandhills grassland type, according to data gathered by the Wyoming Game and Fish Department in 1978. Brewer's sparrows would likely also be displaced until sagebrush reinvades reclaimed areas and grows to suitable height and density. Cottontails and jackrabbits would likely return to reclaimed areas, but in lower numbers due to loss of vegetative (brush) and topographic cover.

The riparian and aquatic habitats would not be replaced under the current reclamation plan, and this would further serve to reduce habitat diversity in the postmining vegetative community.

Sage grouse and sharp-tailed grouse were observed onsite in 1978 by Wyoming Game and Fish Department personnel.

See also comment 14-57.

55. The text of Chapter 2 of the site-specific analysis, Vegetation has been revised.

56. The text has been revised to reflect these facts.

57. The proposed mine in itself may not cause major impacts to fish and wildlife, but if one considers adjacent mines running south to Wyodak, new roads, fences, railroad spurs, increased traffic, noise and human activity, the Buckskin Mine creates more impact on wildlife in an area already heavily impacted by development.

With the discovery of fathead minnows in Rawhide Creek, impacts to nongame fish have changed to minor.

Impact to nongame birds would be major overall, especially to birds requiring sagebrush for nesting, such as Brewer's sparrow, and birds dependent on the riparian meadow habitat. Response 14-54 discusses other terrestrial bird species that would be impacted.

Although the number of reptile and amphibian species is only four, three of the four species depend on the riparian-aquatic habitat, which would be lost during mining and difficult to reclaim to premining diversity. Snakes should be able to reinhabit reclaimed areas. Frogs may inhabit reclaimed areas if suitable habitat exists along other portions of Rawhide Creek, and pools are available for breeding and escape.

Response 14-54 discusses impacts on other mammals.

Although the mine area (1,100 acres of disturbance) is a small part of the total antelope range, the disturbance from adjacent mines and their associated developments, and the disturbance from the Buckskin Mine cannot be divorced. All impacts are related and build up as development increases.

The use of the expression "long-term" in the ES describes impacts lasting after mining and reclamation are completed. Using a figure of 30 years for the reestablishment of big sagebrush, and assuming a 20-year mine life with no reclamation the first 10 years of the mine and over half the acreage reclaimed during the last year of the project, big sagebrush would reestablish itself on the site 10 to 30 years after the end of the project.

58. Assuming that adjacent undisturbed habitats are fully utilized (at carrying capacity), the animals displaced would be unable to compete for food and/or cover or would, in turn, displace those animals already there. This would eventually lead to a net loss of animals due to disturbance. Reclamation would not take place at all during the first 10 years of the project, and probably 2 years would be required to establish a healthy cover of grass. Any shrubs introduced would take several years more to grow large enough to provide effective cover.

See response 14-54 concerning mourning doves and reclamation.

59. Because recreation facilities and resources in Gillette and the surrounding area are already considered overcrowded, any additional population growth would cause a noticeable and significant impact on those resources.

60. The text has been revised to indicate that the ranchers will continue their operations on adjacent and undisturbed areas. See Chapter 3 of the site-specific analysis, Agriculture.

61. The text has been changed.

62. The population increase of 843 refers to the three counties of Campbell, Converse and Crook. The population increase of 730 refers to Campbell County.

63. See response 14-3.

64. These figures exclude corporate income. A footnote has been added to the table.

65. See response 14-35.

66. In Chapter 3 of the site-specific analysis, Soils, we state that such spillage would be localized and of little relative significance. The text has been changed in Chapters 4 and 5 to reflect this.

67. We have checked Committed Measure (F) in Chapter 4 of the site-specific analysis. It is correct.

The channel design to accommodate a single 100-year, 24-hour storm is part of the revised M&RP. Please see response 14-3.

68. A value judgement that the sites are "minor" would have to be relevant to a specific theory, research design, regional plan, or plains occupation model, etc. The importance of these sites to one researcher may be interpreted as minor. Another may consider these sites significant.

The archaeological clearance granted is only by the Wyoming State Archeologist. Cultural resource clearance is determined by the federal agencies involved.

69. Although some land which would be disturbed by the Buckskin project does lie within Carter Oil Company's permit area, Carter's current mining plan, dated December 1977, does not forecast mining of or construction on these lands. The text has been amended to indicate the possibility of future disturbance by another mining company.

70. The text has been revised. See Chapter 8 of the site-specific analysis, alternatives to the proposed action.

71. This proposed alternative would not necessarily preclude livestock grazing as a postmining land use. Shell's M&RP (May 1977) for the Buckskin Mine states that wildlife use of the area is third in economic or social value behind grazing and hay production.

15

Energy Transportation Systems Inc.
212 Petroleum Building
111 West 2nd Street
Casper, Wyoming 82601
Telephone (307) 265-1800

ETSI

December 8, 1978

Team Leader
Coal ES Team
951 Union Blvd.
Casper, WY 82601

Dear Team Leader:

Here are a few comments for the draft EIS, Eastern Powder River Coal:

1 1 - Page R1-18 indicates that a water-cooled power plant has a water requirement of 10 acre-feet per megawatt. This should be checked against the Dave Johnston or Jim Bridger requirements or the Missouri Basin requirements. I think you will find it's about 50% too low.

2 2 - Page R3-7. The severance tax of 8½% on coal omits the 1.6% impact tax fund which would bring the total severance tax on coal to 10.1%.

3 3 - Page R2-89. The location of the proposed coal slurry pipeline is inaccurate. I would suggest that you either see me or see the system description that we prepared for the BLM Department, Cheyenne office, in May 1978 as part of our right-of-way crossing application.

4 4 - Page 7-1. The loss in human life for coal strip mining was estimated but the loss in human life for the increased train traffic has been omitted. There are other reports in which this was estimated. For example, the National Transportation Safety Board could provide you with an estimate or see page 3 of the attached "Export Options for Wyoming Coal." Most of the information on the above was gleaned from your 1974 report on the same subject.

5 5 - Chapter 8 Alternatives, omits the alternative of coal slurry pipelines and their corresponding mitigating measures.

"Slurry Pipelines — Moving The Nation's Coal Safely, Cleanly, Silently, Cheaply"

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Page Two
Team Leader
December 8, 1978

For your background information on ETSI coal slurry pipelines, we enclose a copy of our brand-new ETSI brochure which may have information useful to you.

Very truly yours,

F B Odasz

Frank B. Odasz, P.E.
Rocky Mountain Area Manager

FBO/cr

Enclosures

<u>Letter 15 Responses</u>

1. Annual average water usage for the Laramie River Station at Wheatland, Wyoming will be an estimated 16,008 acre-feet, or 12 acre-feet per megawatt; maximum usage will be 27,130 acre-feet, or 18 acre-feet per megawatt (REA 1976). These figures correlate with hypothetical water consumption rates for water-cooled plants (Nehring et al. 1976 and Freudenthal et al. 1974). Unit #4 of the Dave Johnston Plant uses approximately 10.6 acre-feet per megawatt (personal communication, Bruce Beaudoin, Pacific Power and Light 1978), which corresponds with the hypothetical rate used by Harza Engineering (1976) in their analysis of resource requirements for the Yellowstone River Basin. According to Mr. Beaudoin, Units #1, #2, and #3 use slightly less. Since the Dave Johnston Plant is the only water-cooled plant expected to exist in the ES region through 1990, it seems logical to retain the figure of 10 acre-feet.

2. The text has been revised in Chapters 2 (Socioeconomic Conditions) and 3 of the regional analysis.

3. The figure in Chapter 2 of the regional analysis which shows major pipelines has been changed.

4. In order to develop data on increased loss of human life for increased coal train traffic it would be necessary to know the types of crossings, the average daily vehicle traffic at each crossing, the number of trains per day, and whether or not each crossing is rural or urban. A section has been added to Chapter 2 of the regional analysis which discusses vehicle-train accidents.

5. Coal from the mines discussed in the probable level of regional development is already being shipped via rail. Plans are firm for increased production from these mines to be shipped by rail or slurry pipeline. Therefore, shipment of coal by slurry pipeline or other form of transportation is not a reasonable alternative for these mines. Some of the mines discussed in the high-level scenario, for which firm plans have not been made, might use slurry shipments. At the time site-specific analysis of any new mining proposal is done, slurry shipment of the coal could be considered.

16

Texas Energy Services, Inc.
a Kaneb company
1001 Douglas Highway • Gillette, Wyoming 82716 • (307) 682-5555

Philip L. White
Vice President

November 30, 1978

Bureau of Land Management
Team Leader Coal E. S. Team
951 Union Blvd.
Casper, Wyoming 82601

Attn: Ms. Julie Elfwing

RE: Eastern Powder River Basin Draft Environmental Statement

Written Testimony Regarding:

Texas Energy Service's Rourke, Amax Property, South of Gillette, Wyoming.

On brief review, I am submitting the following in hopes of acquainting you with our attempts to develop the Rourke, Amax properties. I have enclosed an attached outline which briefly describes our property, its reserves, and our plans to develop it.

Texas Energy Services Incorporated, a wholly owned subsidary, was recently established to represent Kaneb's interests in western developments. Chief amongst these is its joint venture interests in partnership with Northwestern Mutual in the development of its surface interests described herein.

Kaneb Services Incorporated is a relatively small firm seeking to establish a coal property in the West to augment its other interests back East. It's primarily an energy oriented firm involved in oil and gas production, coal production and sales, off-shore drilling, reservoir engineering, pipeline technology, and transportation, etc., in addition to its financial, computer, and data services.

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Page two

In pursuit of the latter, Kaneb acquired the Rourke and Amax properties in 1977, South of Gillette. With reserves of approximately 800 million tons, and an overall stripping ratio of 3 to 1, it's Texas Energy's intent to establish a viable mining venture on these properties.

Having not clenched the deal for the Amax property, the Rourke property was accordingly submitted for site specific leasing. It's the acquisition of the Amax property however, with its better stripping ratio, that ultimately led to our concerted efforts to develop same.

Where as, the Rourke property could undoubtably be developed on its own merits, the acquisition of the Amax property enhanced our position with regards to leasing. Together they formed a logical mining unit contiguous to the Carter and Amax properties allowing for the full and orderly exploitation of known economic reserves in this area.

In line with the latter, we're currently engaged in acquiring a site, off coal, for our plant, and certain properties bordering on ours, overlying state and federal coal.

Due to the fact that we have coal in commercial quantities,of compliance quality, with moderate overburden ratios, readily available, and in as much as we believe we should be able to obtain a Federal Coal Lease, we are proceeding with preparations to develop the property. Accordingly, we are currently readying same with the assistance of the following firms:

Pincock, Allen, & Holt Inc.	-overall mining plan -equipment selection -manning projection -capital & operating costs -financial reviews
Bullock Engineering and Development Company	-plant design and layout -equipment selection -capital & operating costs -construction management

Page three

16

IntraSearch/Rawlins (Consulting Geologist)	-reserve definition -reserve computations -topos, isopachs, cross-sections
Eldorado Exploration Co./ Digilog Inc.	-reserve logging and drilling
Commercial Testing & Engineering	-core laboratory analysis
Warner White Ecological Consultants	-environmental reconnaissance -baseline studies and monitoring -reclamation planning
Summit Inc./Larson, Hisk & Brimacombe	-county road relocation

In addition to the letter, we are engaged in numerous attempts to market our reserves. In anticipation of a three-fold increase in their commitments in 1990, various western and mid-western utilities have expressed an interest in acquiring our coal. Contracts could be negotiated today if we held a Federal Lease.

No known encumberances inhibit our ability to develop the property. We've won agreement from Tri-County Electric for the relocation of their powerlines so as not to prohibit mining. We've removed county road T-7 which criss-crossed our property and relocated the road to the south of our boundary with Amax Coal Company.

Environmentally we have found nothing which would preclude our developing the property. We believe in fact that we can improve upon the current status of these lands, providing for improved ranch and farm lands following mining. As far as we can tell, the property lies outside of those areas in which various groups expressed environmental concern. We've been unable to locate the supposed sage grouse strutting grounds located or bordering thereon and doubt that current usage would allow for same.

1 We believe we have a viable property and we wish to develop it. Accordingly, we ask for incorporation of our plans in the Eastern Powder River Basin Environmental Statement.

Respectfully,

Philip L. White
V.P./Project Manager
Texas Energy Services, Inc.

Attachments (2)

cc: File
J. J. Kocian

Letter 16 Response

1. Your comment requesting incorporation of a site-specific proposed development into the Eastern Powder River Basin Environmental Statement (ES) has been considered. As a result of the court decision in the Natural Resources Defense Council v. Hughes case, this ES can include for analysis only existing federal coal leases for which mining and reclamation plans have been accepted by the Department of the Interior.

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The Wyoming Chapter of the Sierra Club
Secretary: 750 North Sixth St., Laramie, Wy. 82070

FRIENDS OF THE EARTH, INC.
Wyoming Coal Consultant: 260 North Fourth St., Laramie, Wy. 82070

Team Leader
Coal ES Team
951 Union Blvd.
Casper, Wy. 82601

December 9, 1978

Dear Sir;

Enclosed please find the comments of the Wyoming Chapter of the Sierra Club, and Friends of the Earth in Wyoming, on the Draft ES on development of Eastern Powder River Basin coal. These comments are not in the style which the Wyoming Chapter of the Sierra Club and Friends of the Earth in Wyoming prefer to use; however, it has been concluded that further elaboration is futile. The astonishing lack of reflection of the fact that mining has proceeded in this region for a number of years is directly relevant to the inability to evaluate the statement. There is, to put it bluntly, very little here to evaluate. If there has been an effort to monitor the effects of current and previous mining activity, it is hoped that this will be reflected in the Final ES. The present draft cannot be approved.

One shining exception to the disapproval is the explicit commendation of the socioeconomic and sociocultural material. These sections are excellent.

Within the region of analysis, there is no reason to believe at this time, on the basis of the information presented in this statement, that the relevant Federal

agencies have performed any function other than some sort of approval or disapproval licensing function. It does not seem probable that this is the case; indeed, it would be unlikely that no monitoring of the effects of current coal mining activity has been undertaken. However, the draft statement fails to demonstrate the existence of such monitoring. It is urged that the results of studies undertaken be presented in the final version.

It is noted that the Shell Oil Company has proposed a coring and evaluation program for analysis of the overburden in the proposed Buckskin minesite. Given permit stipulations that this will be carried out, and the toxic or undesirable strata will be isolated from groundwater, by encapsulation in impermeable material or other effective means, these measures alone render the proposed mine more acceptable than other mines in the area. It is urged that such requirements be imposed on all regional mines, as part of a continuous program of hazard identification and mitigation.

It is specifically noted that the only apparent identification of cumulative mining effects to date may be in the assumed baselines utilized for air pollution prediction, although no data for 1978 was used. This is not evidence of competent professional management of the public domain.

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The Wyoming Chapter of the Sierra Club
Friends of the Earth in Wyoming

Team Leader; Coal ES Team; December 9, 1978 -3-

If the difficulties of time pressure imposed upon the ES Team in the preparation of this statement are the reason for the lack of updated information, and evidence of research on the affects of current mining activity in the region, it is hereby urged that the relevant authorities allow their staff sufficient time to prepare an adequate statement.

For purposes of the preservation of legal objections, it is hereby stated that no challenge to the adequacy of the statement and the management procedures employed is anticipated insofar as the statement and the management procedures relate to the socioeconomic aspects of development.

Sincerely,

John Winkel

John Winkel
Secretary, Wyoming Chapter of the Sierra Club

John D. Wiener

John D. Wiener, Esq.
Wyoming Coal Consultant to
Friends of the Earth in Wyoming

Enc.: 10 pp.

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Re: Trace elements and contaminants.

Although the regional section of this statement is described as an "update" of the previous regional statement, (pp. R1-1, R2-1, R4-1), there appears to be little support for this description in the treatment of all aspects of impact except the sociocultural profile. Why is there no data presented on the subject of possible toxicity, or discovered toxicity, or absence
1 of toxicity in the overburden and subjacent materials from the existing coal mines in the region? Because of the lack of reporting of any work done in this area, it appears that no work has in fact been done. The statement provides information which is sufficiently generalized that no conclusions can be reached. It is absurd to attempt to predict what will happen if an activity is continued and enlarged without seeking information on existing affects of the current activity. Yet this appears to be expected from this statement. The failure to monitor the effects of current mining, beyond seedling-survival rates on attempted reclamation areas, is a serious lapse of managerial responsibility.

It is known that the University of Wyoming team which researched the Black Thunder mine, for the Atlantic Richfield Co., discovered significant discontinuities in the deposition of toxic material in coal-adjacent materials. This would indicate that special overburden management could significantly reduce hazards from such material. Isolation of the toxic strata is clearly required, and yet there is no indication of such

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techniques. There is no indication of any research directed toward discovering where such techniques are required, or would be helpful. Coring of the overburden and subjacent strata, and analysis of the cores is certainly appropriate in all cases, and if depositional patterns of toxic elements and combinations of elements are discovered, suitable isolation should be required. This should be a permit stipulation in all permits, whether new or re-issued under the forthcoming SMCRA regulatory programs.

It is acknowledged that uranium could exist in the overburden material of the region. (p. R2-74). It is stated that data on water from overburden material are inconclusive, (p. R4-19 - 20), although the potential for toxic leaching is certainly present. Table R4-5 indicates that selenium, molybdenum, and lead levels in sagebrush are high, but no information is given on the actual sources of these minerals, and it is noted that sagebrush is not known as being a strong concentrator
2 of trace minerals. No information is supplied regarding plants that are known to convert selenium from inorganic forms to forms which are readily uptaken by other vegetation, or on plants which are known to metabolically require selenium, or to concentrate dangerous levels of selenium - despite the fact that these plants are well known to exist in the region. No information is presented on levels of uranium in any vegetation or animals in the region. It is acknowledged that chronic poisoning may be caused by elements known to exist in the region, which are transported from the site of the ecological exposure by water and air trans-

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port mechanisms. (pp. R4-19, 22-23, R4-35). No information is
3 presented regarding sulfur content of the coal and overburden in the region, or in existing mined areas, and no information is presented regarding generation of sulfuric acid, with atten-
4 dant increases in leaching, due to exposure to air and water of sulfates. Suspended particulates are not analyzed for chemical content, and fugitive dust is not analyzed. In light of the EPA definition of fugitive dust as originating from native soils, may it be assumed that all fugitive dust which rapidly settles out of the atmosphere does in fact originate from native soil? Whether emissions may be legally classified as fugitive dust may be settled by analysis of the dust. If it contains elements
5 which are in greater or significantly different proportions than those found in "native soil", then the emission is subject to legal limitations which would otherwise not apply. Yet there is no information on this. There is no information on the synergistic toxicity (or antagonistic non-toxicity) of materials which are no longer immobilized due to mining. While this may have been inevitable before significant mining occurred, it may not be inevitable now.

Overall, there are serious gaps in the statement. Many could have been filled by effective managerial monitoring of the effects of current mining. But it appears that once a project is licensed, no further analysis occurs. That would be unacceptable. Further failures would also be unacceptable.

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Re: Hydrology and water quality.

While there is an overall impression that there
is actual data on these subjects, the presentation is so
nebulous that commenting is extremely taxing. For instance,
a critical observation is that local reversals in flow may occur
as topographic surface is lowered below potentiometric surface
6 and aquifer levels in specific mine sites. (p. R4-17). But,
where will discharged water go? There is simply insufficient
description of actual water movements in these areas. Rahn's
statement that spoils transmit almost as well as the aquifers
they replace does not relate to reversed flows. There is no
consideration of normal upward flow from unsaturated areas to-
7 ward a frozen surface. It is acknowledged that restoration of
original conditions may be impossible where mining occurs below
potentiometric surface, but no quantification of discharge into
8 mine pits is offered, nor is there offered any information on
transmissivity of the substrate below the mined seams. It appears
to be impossible to predict actual hydraulic adjustment without
site-specific analysis; perhaps no regional treatment has yet
acheived accuracy in regard to highly idiosyncratic conditions.
But there appears to be no effective analysis of what may be
9 expected in even archetypical situations despite the existence
of extensive mining.

Assuming, for instance, that ultimate resolution
may be impossible without site-specific analysis, it should at
least be possible to treat this subject in terms of the limits

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which may be imposed by known possible situations. What are
the effects of subjacent impermeable shale strata? Should there
10 be permit stipulations directed toward prohibition of perforation
of such strata? It is unclear whether this particular situation
even exists within the region. Description of the alterations
of aquifers is difficult, to say the least, without knowledge
of the characteristics and location of the aquifers.

Given the high probability of quality degradation
due to mining and storage of fragmented overburden, it is
certainly desirable to assess the ultimate destination of the
degraded waters. "In areas where bedrock aquifers discharge into
spoil, the water moving into the spoil would probably increase
somewhat in dissolved constituents." (p. R4-19.) This quotation
illustrates the frustrations of the statement. In what areas
do bedrock aquifers discharge? Will spoil be stored or re-
11 placed in such locations? Is this avoidable? What are the
possible dissolved constituents? To what extent will they in-
crease? To what extent is that avoidable? While being fully
aware of the suspect nature of the use of statements out of
context, the inconclusive nature of this statement is such that
one may question its semantic and informational value.

Criticism of every statement of this type would
be merely annoying, given their prevalence. It appears that
the statement can be boiled down to a large number of questions
without answers. Granted that site-specific analysis may be
required to provide answers, it would seem far more useful to

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present the results of actual research on mines which already
exist, and which are selected on the basis of the variety of
12 situations which they present, or at least to perform detailed
theoretical modelling of archetypical situations. If the
facts are not available, it should be stated that this is the
case. What reasons may exist for the apparent paucity of
information are open to question. But at this time, it can
be stated with assurance only that the environmental impacts
of coal mining on the aquifers, surface waters, and hydrology
and water quality of the analysis region are unknown.

It is hoped that the final statement will supply more information, even if it is necessary to delay the issuance of the final statement until research can be completed.

17

Re: Socioeconomic Analysis

The authors of this exceptionally well-drafted section deserve sincere congratulations and gratitude. The depth of analysis and fairness of consideration is especially welcome. The quality of this section is far superior to the usual treatment in statements of this type. The attitude and cultural values material is excellent, as is the financial analysis of the local governments. It could be desired that further work be done on the local inflationary spirals which are generated by large influxes of highly-paid transients, but the housing analysis does address this, to some extent. Further data on food prices, and increased rentals of existing units would be helpful. It is deeply regretted that the remainder of the statement fails to meet this standard of quality.

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Re: Reclamation.

There is no indication in the statement that toxicity is considered in evaluation of reclamation plans or efforts. The guidelines mentioned on p. R1-14 omit such con-
13 siderations as toxicity of new vegetation, biomass and bioassay procedures and evaluation, and also omit any post-mining evaluation of effects on groundwaters, and hydrology of the allegedly reclaimed area. The fact that plants of unknown content are growing on land which is covered with material of unknown content does not appear to be a sufficient measure of the success of reclamation. There is no apparent information on the amount of water to be used during reclamation (e.g., Tables R1-7 and 8), or on the expected necessity for water use
14 after mining has terminated, for erosion control as well as reclamation. The climatic data appears to be old, and therefore, fails to indicate whether any effects have resulted in the local microclimate from the recent vast increases in parti-
15 culate and dust emission. Data presented on pp. R2-1 through 11 appear to have been acquired during 1921 - 1955. Therefore, affects of coal mining on, for example, snow structure and rate of fall, or rate of local rain shower activity, is lacking. Therefore, the data in the section on growing season is suspect.
16 (p. R2-1 et. seq.) Although the surface-management agency is to inspect for compliance with stipulations in permits, no stipulations are mentioned. (p. R3-11.) It is acknowledged that various plans may be defective, due to increased levels of

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erosion, headcutting, and other factors. Yet despite the statement that difficulties are occurring in maintenance of
17 unreclaimed overburden, mitigation measures are not described. (p. R4-22;) It is stated that no adverse chemical characteristics appear to be present in ten feet of overburden above the Wyodak coal seam, and therefore that the overburden is not toxic. But no supporting data is provided, and clearly on the
18 basis of the discontinuous deposition patterns of toxic elements which was found at the Black Thunder mine, the allegation is not probative. Further, its informational value is questionable, due to the apparent widespread differences in local concentrations of toxic elements. Both of the reclamation efforts described include seeding with four-wing saltbush which is known to be a heavy concentrator of selenium.
19 This might well be justifiable if the plants of the genera Atriplex were selected for use to allow subsequent removal for bioassay. However, this does not appear to be the case.

No evaluation of any worth can be made on the basis of this insufficient information.

17

Re: Air Quality

In light of the definition of "fugitive dust" as "particles of native soil which are uncontaminated by pollutants resulting from industrial activity", (p. R3-5), it is here specifically noted that the application of this exemption from regulations designed to prevent significant deterioration of air quality, and other emission limitations is suspect. As is apparently the case in every aspect of environmental impact with the exception of surface plant growth on reclamation attempts, there appears to be no monitoring effort expected, predicted, or required. This also is cause for serious concern, and further investigation.

It is noted that certain of the mines are predicted to produce enormous amounts of fugitive dust, such as Eagle Butte, Belle Ayr, and the Cordero mine, as well as the Highland uranium operation. It is expected that managing agencies and mine operators seeking to apply the fugitive dust exemption from regulation will provide for unbiased evaluation of the content of their emissions as a measure necessary to avoid liability.

Letter 17 Responses

Some of the concerns expressed throughout the Sierra Club/Friends of the Earth letter are of a general nature; they are related to impact monitoring, results of past mining, and toxic materials. A discussion of these matters follows.

Regulations promulgated under the Surface Mining Control and Reclamation Act (SMCRA) provide for monitoring of air quality, surface water, and groundwater, and for identification and isolation (from root zones and groundwater) of toxic materials. These regulations apply to all ongoing coal operations on federal leases in accordance with promulgation of final federal lands program regulations under SMCRA.

Wyoming laws also provide for the monitoring of water discharged into surface waters, of air quality before and during mine operations, and of reclamation according to an approved plan.

All results of soil sampling, overburden testing, and monitoring are a matter of public record. Members of the team used such data available to them in writing the description of the environment and the impact analysis. Because monitoring requirements are recent or, in some cases, not yet effective, data are sparse. Data gaps are, however, pointed out in the text. Please see also responses 17-9 and 17-12.

With regard to delaying publication of the final ES, please see response 33-14.

1. Trace elements considered to be of environmental concern (antimony, arsenic, cadmium, copper, fluorine, lead, lithium, mercury, selenium, thorium, uranium, and zinc), along with other trace elements, have been analyzed from Wyodak-Anderson coal, surface and near surface materials (0 to 6.6-foot depths), and overburden rocks (10- to 166-foot depths) in the Powder River Basin by the Geological Survey (Keefer and Hadley 1976). Available data on the geochemistry of overburden rocks based on the above analyses show a relatively wide range of concentration for many elements. Table 1, below, summarizes some of the results of the Geological Survey analysis program. Data from the first (1974) and second (1975) annual progress reports of the Geological Survey geochemical surveys of the western coal regions are included in the table. This is a continuing program and subsequent annual progress reports will add to the analytical data.

Keefer and Hadley (1976) state:

> The greatest potential for change in the chemical makeup of surface materials stems from the substitution of overburden rocks for surface soils following strip mining. This potential may be minimized by the removal, stockpiling, and subsequent return of existing surface and near-surface soils and rocks as topdressing on mine spoils. As indicated in Table 1, the few localities in which these materials have been sampled show little change in geochemical properties from the surface downward to 6 to 7 feet (about 200 cm).
>
> One inevitable result of surface mining, however, is that still more deeply buried, relatively unaltered rocks will be brought closer to the land surface in many places and subjected to the natural cycle of leaching.

weathering, and erosion. Although available analyses on overburden rocks (Table 1) indicate higher concentrations of some trace elements as compared with concentrations in surface and near surface materials, conclusions have been reached that (1) when the higher values for the samples that were analyzed are averaged with those of other samples from the same core, their significance is minimal; (2) none of the elements occurs in abnormally greater amounts than are present in similar rock types throughout the United States; and (3) the presence of toxic trace elements (those indicated in Table 1) serves as a warning of potential pollutant or contaminant but does not necessarily indicate that toxic concentrations would result from the oxidation and leaching of overburden materials. Few oxidation and leaching tests, however, have yet been conducted for overburden rocks in the Eastern Powder River Basin.

TABLE 1

CONCENTRATIONS OF TRACE ELEMENTS IN WYODAK-ANDERSON COAL, SURFACE SOILS, NEAR-SURFACE SOILS AND ROCKS, OVERBURDEN ROCKS, AND SAGEBRUSH IN THE POWDER RIVER BASIN

Element	Wyodak-Anderson coal (reported on whole-coal basis)		Sagebrush ash (Artemisia tridentata)		Surface and near-surface materials						Overburden rocks	Average concentrations in rocks of the Earth's continental crust
					Depth: 0-1 inch (0-2.5 cm)		Depth: 6-8 inches (15-20 cm)		Depth: 3.3 feet (1 m)	Depth: 6.6 feet (2 m)	Depth: 10-166 feet (3-35.5 m)	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Range	Range	Range	
Antimony*	0.3	<0.1-.7	--	--	1.2	--	1.1	--	0.4-.9	0.9-1.0	1.6-2.9	0.2
Arsenic*	1.9	<1-4	--	--	7.2	--	8.2	--	4-5	2.6-8.6	3-70	1.8
Cadmium*	.1	<.1-.12	6.8	1.3-30	--	--	--	--	--	--	<1-2.5	.2
Copper*	13.2	3.3-51	--	--	16	3-30	18	5-50	7	7-20	10-60	55
Fluorine*	47	30-200	--	--	--	<400-2,200	--	<400-1,200	--	--	260-840	625
Lead*	4	<1.5-8.2	65	<30-150	18	10-30	18	10-100	15	15	<25-30	12.5
Lithium*	2.5	<.5-49	12	2-48	22	11-35	25	24-47	9-15	12-21	11-50	20
Mercury*	.14	.05-.29	--	--	.022	.01-.04	.025	.01-.04	.01-.02	.02-.03	.02-.15	.08
Selenium*	1.5	.3-6.7	.68	.08-4.8	.20	--	.14	--	<.1-.3	<.1	<.1-1.4	.05
Thorium*	1.5	<1.5-7.9	--	--	9.6	5.3-15	9.8	5.6-15	8.4-9.8	6.7-9.7	7.3-18.3	9.6
Uranium*	.8	<.2-3.2	.72	<.4-3.5	3.1	1.7-7	3.2	2.2-7	2.2-2.4	2.0-2.2	2.3-6.9	2.7
Zinc*	7.5	2.1-25	430	200-800	62	28-93	64	25-104	28-35	32-49	30-375	70

Modified from Keefer and Hadley 1976

Note: Analyses performed in Geological Survey laboratories. Symbol < indicates concentration is less than the value shown. Leaders (...) indicate no available data. Asterisk (*) indicates elements generally considered to be of environmental concern. All values are in ppm.

2. An addition has been made to the text in Chapter 4 of the regional analysis, Vegetation.

3. See response 17-4.

4. No information was presented regarding the generation of sulfuric acid because it is not a problem in the area. The groundwater in the coal and adjoining aquifers has a high pH (Hodson et al. 1973) and is highly buffered. Where groundwater is discharged at the surface it remains in a basic environment, so there is small, if any, change in pH. Examples of high pH water that are, or may be, influenced by strip mining are in the abandoned Hidden Water Mine near Sheridan, where the pH of the water is about 8 and in Donkey Creek below the Wyodak Mine where the lowest of five pHs measured in the period August 1975 to August 1977 by the Geological Survey was 7.7.

The generation of H_2SO_4 in air from SO_2 or SO_4 emissions (most of this generation will occur by the oxidation of SO_2 to SO_3 or SO_4 compounds and then reaction with water) is a relatively slow reaction in the atmosphere and is dependent on solar radiation. The increased amount of H_2SO_4 produced as a result of the SO_2 emissions from the mines should be small, due (1) to the low level of SO_2 emissions from the mining operations, and (2) to the low sulfur content of the coal itself.

5. No chemical analysis of the total suspended particulates (TSP) associated with the proposed mines has been performed. It is assumed that chemical composition of the TSP will be similar to that of the native soil in the areas to be disturbed. Analysis of the chemical composition of the native soil has been performed. (See Chapter 2 of the regional analysis, Soils.)

The only other major source of TSP besides the fugitive dust is the coal itself. Some preliminary analyses for chemical composition of the coal have been performed on the coring samples. It is also standard procedure to perform this type of analysis as the coal is mined. See Table 1, response 17-1.

There has been no research work done on the synergistic toxicity of the emissions associated with a rural coal mine. Studies in this area of air pollution have only been done in urban areas. Their results are not applicable to the mining operations discussed in this ES.

6. The water would flow into the mine pit.

7. It is correct that Rahn's work described saturated flow. Vapor transfer under a gradient temperature was not considered in writing the ES. A cursory check of the literature indicates that water movement toward the frozen surface would occur in areas of high water tables in the winter, but a reverse flow, of approximately the same amount, would occur in the spring. Therefore, the overall change in water by this mechanism is considered minor, and a section describing the movement has not been added.

8. Estimation of discharge into the Buckskin Mine pit is given in the site-specific analysis, Chapter 3. Flow into the Belle Ayr Mine is reportedly about 100,000 gallons per day but this includes runoff from precipitation.

Wells described in Table RB-2, Results of Aquifer Tests, that are completed in strata below the coal are Rozet #5, and Wyodak Wells 5, 6, and 7.

9. The impact of the Wyodak Mine on the water level in the coal is shown in Figure R4-10. There are, to date, no reclaimed areas at the Wyodak Mine with saturated spoil from which to obtain data on the hydrologic conditions in the reclaimed areas. The Wyoming Water Resources Institute has prepared an analysis of the hydrology of reclaimed areas at the Belle Ayr Mine in draft form and publication is expected by March 1979. Other mines are too new to generate this type of information.

10. Subjacent impermeable strata, where present, will impede the vertical movement of water. Assuming the concern is for pollution of an underlying aquifer by vertical movement, there are no prohibitations against perforation, but there are regulations protecting aquifers such as Wyoming law:

> § 30-96.14. Drill holes to be capped, sealed or plugged. -- All drill holes sunk in the exploration for locatable or leasable minerals on all lands within the State of Wyoming shall be capped, sealed or plugged in the manner described hereinafter by or on behalf of the discoverer, locator or owner who drilled the hole. Prospecting and exploration drill holes shall include all drill holes except those drilled in conjunction with the expansion of an existing mine operation or wells or holes regulated pursuant to chapter 6, title 30, Wyoming Statutes 1957, Compiled 1967. (Laws 1971, ch. 248, § 1.)

Subjacent, relatively impermeable strata do occur in the region. See Chapter 2 of the regional analysis, Water Resources, Groundwater, Fox Hills Sandstone... .

11. Figure R4-10 shows the gradient down which water flows; the discharge would be focused at the mines. Spoil will be stored in these locations, and this is unavoidable because spoil will be placed next to the coal at the edges of the leases to conform with regulations on reclamation. Water is probably the most universal solvent, so it is possible that about anything in contact with the water could be dissolved, depending on such things as temperature, pressure, oxidation-reduction potential, pH, and reactions with other constituents. On the other hand, probable constituents are those found by Rahn (1976). It probably is not possible to identify the change in a natural system, because the amount of water moving regionally in the coal is small compared to local recharge. Therefore, local conditions will dominate and mask other changes.

12. Modeling was beyond the scope of this ES. However, the Bureau of Mines has let a contract to a consultant for modeling shallow aquifers in the Powder River Basin, and the Geological Survey has ongoing studies that include modeling of the deep and shallow aquifers in the basin.

13. The guidelines were established to provide a consistent approach for the team in their analysis and are not meant to evaluate effects.

14. The mining and reclamation plans used in the preparation of the analysis generally state that supplemental watering of reclaimed areas will not be done or will be done only when needed to establish early growth.

15. The climate data presented in Chapter 2 was used because of the availability of the STAR (Stability Array) data deck associated with them. The STAR data deck was necessary for modeling the emissions from the mines and the surrounding areas. It was felt that this data was adequate in that the climatic conditions between 1921 and the present were fairly constant. No change in regional climate due to coal mining is expected.

16. Stipulations are placed on a lease at the time of issuance or on a mining and reclamation plan at the time of approval. Stipulations on a mining and reclamation plan result from concerns and problems discussed in the environmental statement.

17. Reclamation measures such as contouring and revegetation are prescribed to prevent water erosion. Mitigating measures listed in the ES are those legally required or committed by an agency or private organization. Other means to reduce impacts can be suggested as alternatives on a site-specific basis, as appropriate.

18. See response 17-1.

19. An addition concerning selenium-converter plants has been made to the text in Chapter 4 of the regional analysis, Vegetation.

18

Team Leader
Coal E.S Team
951 Union Blvd.
Casper, Wy 82601

12-11-78

Dear Sirs,

I have not had an opportunity to finish reading the coal E.S. at this time. However, please find enclosed a map of the Thunder Basin National Grasslands. It contains the current Prairie Dog towns to 1978 which are located in the Grasslands. I hope you will Include these on your map of Small Animals.

Sincerely
Roy J Reichenbach
Manager
Thunder Basin Grazing Assn.

Letter 18 Responses

1. The small animals map (Map 7, Appendix A) has been revised to include your new information.

19

United States Department of the Interior

NATIONAL PARK SERVICE
ROCKY MOUNTAIN REGIONAL OFFICE
655 Parfet Street
P.O. Box 25287
Denver, Colorado 80225

IN REPLY REFER TO:
L7621 (RMR)PC

DEC 8 1978

Memorandum

To: Team Leader, Coal ES Team, Bureau of Land Management, Casper, Wyoming

From: Regional Director, Rocky Mountain Region

Subject: Review of draft environmental statement for the Eastern Powder River Coal Region of Wyoming (DES 78-48)

We have reviewed the subject statement and offer the following comments:

The proposed mining activities would not directly impact any units of the National Park System. The increase in population from the labor force may result in some increase in visitation to areas such as Devils Tower National Monument and Fort Laramie National Historic Site, Wyoming; and Jewel Cave National Monument, Wind Cave National Park, and Mount Rushmore National Memorial, South Dakota; but there is no way of quantifying what that impact might be. We expect it would be a rather small percentage of the thousands of people that visit these areas annually.

1 Also, as noted on page BU3-7, current Environmental Protection Agency regulations exempt fugitive dust from control under the total suspended particulate increment of the prevention of significant degradation of the Clean Air Act. The regulation in which that position was taken by the Administrator of the Environmental Protection Agency invited input from the public pertaining to the subject indicating that he would consider reversing that preliminary decision. The Service disagrees with this Environmental Protection Agency position. We believe that without adequate control, fugitive dust can become an important factor in the prevention of significant deterioration in pristine air quality areas such as the national parks. Although coal mining is not the sole source of fugitive dust, in this instance it must be considered as a major source. Technology for modeling the transport, dispersion, and concentrations of fugitive dust has developed rapidly. We feel strongly that fugitive dust be included as a controlled

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19

1 emission under PSD for Class I areas. If this is done, additional authorization will be required, including the authority to redesignate road corridors where Class II TSP increments will be exceeded.

We appreciate the opportunity to comment on this environmental statement.

for Glen T. Bean

2

Letter 19 Response

1. This comment refers to EPA regulations rather than the ES; thus no response is necessary.

20

BURGESS & DAVIS
ATTORNEYS AT LAW
SHERIDAN, WYOMING
82801

DEC 13 1978

HENRY A. BURGESS
RICHARD M. DAVIS, JR.

CHARLES R. HART
KIM D. CANNON
TIMOTHY S. TARVER

TELEPHONE
307-672-7491
P.O. BOX 728

December 11, 1978

United States Department
of Interior
Bureau of Land Management
P.O. Box 1828
Cheyenne, WY 82001

Re: Draft Environmental Statement-Eastern Powder River Coal

Gentlemen:

The following brief comments relate to the Draft Environmental Impact Statement for Eastern Powder River Basin.

I understand some individuals at the public hearing on Tuesday, November 28, 1978 represented to you that ranchers in the Powder River Basin were against further coal leasing at any level. Contrary to that position, we have represented and do represent a number of land and mineral owners who desire to have their minerals, and particularly coal, developed. In some cases over 200 individuals will benefit when the coal is mined. From my observations, as long as mineral development takes place in an orderly fashion and in accordance with environmental regulations, most of the land owners affected do not object.

1 One of the problems which we have found to affect land owners in the Powder River Basin, more than others, are the impacts from the location of transportation, transmission and utility easements. It does not appear the draft impact statement adequately comments on the need for a coordinated federal, state and local policy on the location of these burdens within natural corridors. An example is the proposed 230 KV line by Tri-County Electric. That line runs generally north and south. It could be located along existing corridors, particularly Highway 59 or the Burlington Northern right-of-way. Instead, it picks a new corridor, not parallel to either of those mentioned, nor to any existing power line.

20

U.S. Department of Interior
-2-
December 11, 1978

1 Land owners in the area have for years suffered from the helter-skelter and spider-like growth of these easements upon their lands. I recommend the Bureau of Land Management develop a firm policy and not grant easements for right-of-way across federal lands which do not conform to some existing corridor.

2 Finally, I suggest the rules and regulations governing the trading of minerals and surface between the federal government and private individuals be expanded to provide for exchanges of surface and minerals, as well as surface for surface and minerals for minerals. To do so would (1) promote the consolidation of isolated federal surface; (2) promote the consolidation of economically recoverable coal; (3) prevent mining of areas deemed environmentally unacceptable; and (4) promote the orderly development of the general area of the Powder River Basin for the benefit of the land owner, federal government and general public.

Yours very truly,

BURGESS & DAVIS

Richard M. Davis, Jr.

RMD:gkp

Letter 20 Responses

1. The Bureau of Land Management's Management Framework Plan (MFP) (July 1977) specifies that persons constructing new energy transmission or transportation facilities must consider locating them near existing facilities. New corridors will be considered only when location near other facilities is impractical or unsafe.

The text of Chapter 3 of the regional analysis has been amended to indicate this MFP decision.

Bureau of Land Management control over new rights-of-way, however, applies only to federal surface under its jurisdiction. See transcript response #18.

The 230-kv line to be constructed by Tri-County Electric Association, Inc. was the subject of a separate ES published in final form in April 1978 by the Rural Electrification Administration. Several alternate routes were analyzed for visual, safety, land use, and vegetative disturbance impacts, as well as their proximity to strippable coal resources.

2. Section 510(b) of the Surface Mining Control and Reclamation Act provides, in certain circumstances, for the lease of other federal coal deposits to an operator in exchange for relinquishment of leased deposits (minerals for minerals). Section 206 of the Federal Land Policy and Management Act provides for the exchange of federal lands for private lands in certain circumstances. However, the need for mixed exchanges has not yet been demonstrated in the region.

21

UNITED STATES DEPARTMENT OF COMMERCE
The Assistant Secretary for Science and Technology
Washington, D.C. 20230
(202) 377-4335

December 13, 1978

Team Leader
Coal ES Team
951 Union Blvd.
Casper, WY 82601

Dear Sir:

This is in reference to your draft environmental impact statement entitled: "Eastern Powder River Coal Region of Wyoming." The enclosed comment from the National Oceanic and Atmospheric Administration is forwarded for your consideration.

Thank you for giving us an opportunity to provide this comment, which we hope will be of assistance to you. We would appreciate receiving four (4) copies of the final statement.

Sincerely,

Sidney R. Galler
Deputy Assistant Secretary
for Environmental Affairs

Enclosure Memo from: Isaac Van der Hoven
Environmental Research Lab.
NOAA

21

NOV 29 1978

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
ENVIRONMENTAL RESEARCH LABORATORIES R32
Silver Spring, Maryland 20910

November 27, 1978

TO: PP - William Aron

FROM: R32 - Isaac Van der Hoven
Isaac Van der Hoven

SUBJECT: Comments on "The Eastern Powder River Coal Basin of Wyoming" DEIS #7811.09

1 It is assumed that the predicted particulate concentrations shown in figures 8U3-1 through 8U3-8 are calculations using the MCDM-V3 dispersion model with the Buckskin Project as the source. The ambient particulate concentrations are assumed to be the contribution from all other surrounding sources in addition to the Buckskin Project. From the figures, it is obvious that the difference between predicted and ambient is always 12 micrograms/m^3. This then would mean that between 1980 and 1999 no increase in the contribution from all other surrounding sources would be expected, which does not seem reasonable. Also, one would expect a difference between the average annual and 24-hr contribution from the surrounding sources. Finally, the meteorological conditions which can cause a worst-case predicted value from the Buckskin Project can also cause a worst-case situation for the surrounding sources.

22

FEDERAL ENERGY REGULATORY COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

December 12, 1978

Team Leader
Coal ES Team
951 Union Blvd
Casper, Wyoming 82601

Dear Sir:

I am replying to your request 1792 (920) to the Federal Energy Regulatory Commission for comments on the Draft Environmental Impact Statement for the Eastern Powder River Coal Region of Wyoming. This Draft EIS has been reviewed by appropriate FERC Staff components upon whose independent evaluation this response is based.

1 The staff concentrates its review of other agencies' environmental impact statements basically on those areas of the electric power, natural gas, and oil pipeline industries for which the Commission has jurisdiction by law, or where staff has special expertise in evaluating environmental impacts involved with the proposed action. It does not appear that there would be any immediate significant impacts in these areas of concern nor serious conflicts with this agency's responsibilities should this action be undertaken. However, there does not appear to be any recognition of the potential jurisdictional responsibilities of FERC related to the joint venture of Panhandle Eastern Pipe Line Co. and Peabody Coal Co. for a coal gasification facility, a gas transmission pipeline and co-mingling of SNG with natural gas in the interstate system. If the SNG is to be co-mingled with interstate natural gas supplies, FERC jurisdiction will be involved. We recommend that the sections dealing with institutional relationships, laws and regulations be revised to include FERC.

2 In general, staff finds the contents of this DEIS to be satisfactory, but it could be improved with the addition of a benefit/cost analysis and comparison of the various proposed actions and alternative control measures since it is important to strike a balance between economics and environmental impacts.

Sincerely,

J M Heinemann
Jack M. Heinemann
Advisor on Environmental Quality

Letter 21 Responses

1. The assumption that predicted particulate concentrations shown in Figures 8U3-1 through 8U3-8 are calculations using the MCDM-V3 dispersion model is correct. The assumption that the ambient particulate concentration is the contribution from all other surrounding sources in addition to the Buckskin project is also correct. While it is true that the background concentration of 12 $\mu g/m^3$ could change over the years, it was not in the scope of the project to predict such a change. The sole purpose of the site-specific analysis was to predict the particulate concentration that the Buckskin project would contribute to the total suspended particulate (TSP) concentration in areas closely surrounding the mine site. When conducting the analysis on a site-specific basis, there were no means of predicting any possible changes in background TSP concentrations, so a consistency was assumed throughout the study period. These possible changes were, however, investigated in the regional analysis, which was developed simultaneously with the development of the site-specific analysis. Any changes can be substituted for the background concentration of 12 $\mu g/m^3$.

The meteorological conditions which can cause a worst-case situation for the surrounding sources may not necessarily be the same conditions which cause a worst-case predicted value. For instance, high winds, increased activity at the mine site, or an extended period without precipitation (or a combination of these factors) could cause a worst-case predicted value and not cause a worst-case situation for the surrounding sources. The joint probability of having worst-case conditions for both surrounding sources and predicted sources is therefore very low. Thus the annual average for surrounding sources was used in computing worst-case 24-hour situations from the mine site.

Letter 22 Responses

1. The text has been amended. See Chapter 3 of the regional analysis.

2. The Bureau of Land Management does not normally include in its environmental statements benefit/cost analyses or economic comparisons of proposed actions and alternatives. Benefit/cost analyses are prepared separately if needed for consideration during the decision-making process.

23

THE CARTER MINING COMPANY
GILLETTE, WYOMING 82716

DARRELL G. WARNER
Vice President

Post Office Box 209

December 18, 1978

Dreft Environmental Statement for the Eastern Powder River Coel Region
1792 (920)

Team Leader
Coal ES Teem
951 Union Blvd.
Casper, WY 82601

Dear Sir:

The Certer Mining Company eppreciates this opportunity to comment on the ebove-referenced statement. The Dreft Environmentel Statement reflects en extensive effort thet your group devoted to preparing a thorough, comprehensive consideration of the environmental impects of coal development upon the Eastern Powder River Coal Region of Wyoming.

1 With reference to the statement on Page BU1-2 that Carter does not anticipate mining the coel under the railroed right-of-way, pleese be edvised thet The Carter Mining Compeny, operator of the lease, intends to mine ell economically recovereble and seleble coal on the lease. The Carter Mining Compeny has an egreement with Shell Oil to provide for the mining of coel in the right-of-way.

Sincerely,

D. G. Warner

DGW/JMW/elr

Letter 23 Responses

1. The text has been revised. See Chepter 1 of the site-specific analysis, Support Developments.

24

1. Table R2-23, page R2-102

A. Disagree including Evansville, Mills, and Casper under one general heading of Casper unless indicated.

B. Disagree with population estimates for 1973, 1975, 1979, 1978 and related percentages of growth. The City-County Planning Office conducted an on-sight inventory of all residential structures in the County, excluding remote rural areas, in 1975-1976. From this inventory, a total of 20,773 dwelling units were counted. Assuming a similar density of 1970, a total of 61,306 persons were estimated for 1976. (See Exhibit I)

Another inventory was conducted in the fall of 1978 (See Exhibit I) which indicates a total of 24,387 dwelling units and an estimated population of 73,599.

1 C. Disagree completely with estimated population for other areas and related percentages. As indicated in the table, overall growth from 1970 to 1978 was 1,431 persons. This area, which I assume to be the Towns of Midwest and Edgerton; unincorporated areas of Paradise Valley and Mountain View; urban development near and adjacent to Casper, Mills, and Evansville; and all rural development in the County is a rather large and diverse grouping to include without further explanation.

The Planning Department designated the unincorporated areas of Paradise Valley and Mountain View and the urban development near and adjacent to Casper, Mills, and Evansville into a general heading "Special Study Area". This area had 3,031 dwelling units and an estimated population of 9,026 in 1976 and 4,919 dwelling units and an estimated population of 15,950 in 1978.

While detailed population projections were not computed for 1973 or 1975 by the Planning Office, a more realistic projection, using a straight line three percent growth rate from 1970-1976, for table R2-23 is shown on the next page.

24

CITY OF CASPER
Incorporated 1888
Casper, Wyoming 82601
December 6, 1978

PLANNING DEPARTMENT
COMMUNITY PLANNING COMMISSION
HOUSING AND COMMUNITY DEVELOPMENT
PLANNING DIRECTOR
222 NORTH DAVID STREET
PHONE (307) 235-8400

Team Leader
Coal ES Team
951 Union Boulevard
Casper, Wyoming 82601

Dear Team Leader:

Thank you for the opportunity of reviewing the Draft Environmental Statement for the Eastern Powder River Coal Region of Wyoming. I found the report very informative and well documented. As I indicated during the hearing, my primary concern was in regards to the population estimates for Natrona County. Since the hearing, I have had an opportunity to review the entire draft and heve made some comments for your consideration.

If you have any questions or need additional information regarding this matter, please contact our office.

Respectfully,

Lee West
Planner II

LW/jd

24

1970-1973		1973-1975		1975-1976		1978-1979	
Population	% Change	Population	% Change	Population	% Change	Population	% Change
NATRONA COUNTY							
56,018	(3.0)	59,428	(3.0)	61,309	(3.0)	73,588	(9.4)
CASPER							
45,626	(2.7)	48,404	(3.0)	49,877	(2.9)	55,121	(4.8)
OTHER AREAS							
10,392	(3.4)	11,025	(2.9)	11,429	(3.5)	19,467	(19.0)

Supporting documents reflecting 1976 dwelling unit counts and 1978 counts are included for your consideration. (See Exhibit I, II)

2. Table R2-30, page R2-116, Housing Supply

2 A. Agree with housing supply data supplied by myself but question how the data is used in comparison to the population data referred to in Table R2-23. The housing supply data presented only reflects totals for the City of Casper, while the population estimates for Casper includes the City of Casper, Town of Mills and Town of Evansville.

3. Table R2-32, page R2-118, City Housing Market Characteristics, 1978

3 A. Reflect 1977 and 1979 totals for various communities not entirely 1978 totals.

B. City of Casper totals are for 1977 and only reflect the incorporated limits. The 1978 total for the City of Casper is 17,087; Evansville, 689; and Mills, 793; for a combined total of 18,569.

4. Section R-3

4 A. While the section "Planning and Environmental Controls" focuses primarily upon Campbell and Converse counties, I feel that the land use planning process and agencies for the region should also be identified somewhere in the report. (e.i.: Crook, Johnson, Natrona, Niobrara, Sheridan, and Weston)

Mention may also be made regarding the cooperative planning agreement between the City-County Planning Office of Natrona County and the Bureau of Land Management. It is my understanding that Converse County has a similar agreement.

24

5 5. *Table R4-3, Projected Population for Cities In and Near the Region*

A. *Uncertain of the meaning of this table from the text.*

6 6. *Table R4-13, Cumulative Population Projections, 1978-1990*

A. *As indicated previously, I disagree with the 1978 population base of 58,000 for Natrona County.*

B. *Combining population estimates for Casper, Mills, and Evansville, as has been done in Table R2-23, the following are the cumulative projects.*

1978	1980	Annual Rate of Change 1978-1980	1985	Annual Rate of Change 1980-1985	1990	Annual Rate of Change 1985-1990	Annual Rate of Change 1978-1990
				NATRONA COUNTY			
73,588	78,038	(3.0)	90,467	(3.0)	104,878	(3.0)	(3.0)
				CASPER			
55,121	58,478		87,792		78,589		
				OTHER			
18,487	19,560		22,875		26,287		

7 7. *Table R4-18, page R4-52, Projected Cumulative Housing Demand*

A. *As previously indicated, 18,289 dwelling units is the total for the City of Casper only.*

B. *It is not foreseen that the greatest influx of housing for the City of Casper by 1990 will be mobile homes. The urbanized area has experienced an influx of mobile homes, but not the City of Casper, as shown by the following.*

HOUSING TYPE, 1978

	Single Family	Multi-Family	Mobile Homes	Total
Casper	11,478	3,401	620	15,497
Evansville	403	2	283	888
Mills	303	14	379	898
Special Study Area	1,749	70	1,088	2,887
TOTAL	13,931	3,487	2,350	19,768

Letter 24 Responses

Thank you for the information you provided.

1. The population table in Chapter 2 of the regional analysis has been revised so that total population for Casper no longer includes that of Evansville and Mills.

Estimates for 1973 and 1975 have been allowed to stand. The difference between these estimates, which were made by the Bureau of the Census, and City of Casper estimates, is explained in part by the city's assumption that the number of persons per household has held constant, when in fact it has almost certainly declined. The figures for 1978 have been omitted from the revised population table. In the case of 1978, the city's estimates are probably more accurate than those we showed in the draft ES, which did not take into account the unexpectedly large increase in local employment in 1978. Therefore, 1978 figures have been adjusted to those provided by the City of Casper.

Regarding grouping together all other areas, the time allowed for analysis seemed to necessitate concentrating on those localities expected to experience the greatest impacts from energy-related development.

2. Population estimates have been adjusted to show Casper alone, corresponding to the geographical basis of housing data. See the population table in Chapter 2 of the regional analysis.

3. It is recognized that data for Casper, as well as for other communities, necessarily reflects a variety of sources and analytical methods. It was, however, the best data available as of early 1978, and it serves as an adequate basis for further analysis. However, the title of the table has been amended to indicate that data is not exclusively from 1978. See also response 24-2.

4. Campbell County and a major portion of Converse County were selected as the area of analysis for this regional ES. Where it is considered pertinent to impact analysis, regulations, land use planning, and related agreements are identified; in this ES, county plans for Campbell and Converse counties seemed to be relevant. Preliminary contacts between BLM and Converse County have been made toward the development of a planning coordination memorandum of understanding. The agreement is not final.

5. The table has been revised. It shows population projections used for the air quality modeling. See Chapter 4 of the regional analysis, Air Quality.

6. See response 24-1. Casper data has been disaggregated in the final ES.

7. See response 24-2. Since we disaggregated Casper's data from that of suburban areas, we have revised the annual increase in demand for mobile homes in Casper from 14.5% to 8.4%. See housing demand table in Chapter 4 of the regional analysis. Housing demand projections shown in the ES do not purport to be those of the planning department.

8. The population base has been adjusted. See response 24-1.

9. Socioeconomic tables throughout the regional analysis have been adjusted to reflect the higher population base.

24

HOUSING TYPE, 1978

	Single Family	Multi-Family	Mobile Homes	Total
Casper	12,588	3,868	855	17,091
Evansville	403	2	283	688
Mills	350	14	429	793
Special Study Area	2,758	115	2,048	4,919
TOTAL	16,077	3,999	3,415	23,491

C. *The Planning Office has not projected housing types through 1990.*

7 D. *A problem I see is the interchange of terminology between Casper and Natrona County which should be clarified somewhere in the report.*

8 8. *Table R8-12, Table R8-34, Low Level Scenario and High-Level Scenario reflect 58,000 population data base.*

9 9. *Other tables reflecting a population base of 58,000 are indicated throughout the report, e.i.: Health Care Requirements, Health Facilities, Particulate Emissions, etc.*

10 10. *R2-111 - Change police ratio of cars to 3.0 instead of 3.7.*

11 11. *Request that you examine all other figures with the respective City and County Departments.*

10. The ratio of one police car to every 3.7 officers reflects the number of sworn officers (70) and the number of fully equipped vehicles (14 marked, 5 unmarked) as furnished by the Casper Police Department in April 1978.

11. It is believed that figures on facilities and manpower cited in the ES were correct in early 1978 and are adequate for purposes of this analysis.

25

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Rocky Mountain Region
11177 West Eighth Avenue, Box 25127
Lakewood, Colorado 80225

1950
December 8, 1978

Team Leader
Coal ES Team
951 Union Blvd.
Casper, Wyoming 82601

Reference: DES - Eastern Powder River Coal Region of Wyoming

We have reviewed the Draft Environmental Statement for the Eastern Powder River Coal Region of Wyoming that includes portions of the Thunder Basin National Grasslands and do not have any substantive comments. Any editorial revisions can be made by the Forest Service representative on the ES Team.

Wayne Cone
for CRAIG W. RUPP
Regional Forester

Letter 25

No response required.

26

Powder River Basin Resource Council

Sheridan, Wyo. 82801 — 48 N. Main ~~150 W. Brundage~~ (307)672-5809

Douglas, WY 82633 — 214 S. 4th St. (307)358-5558

December 18, 1978

Team Leader
Coal ES Team
951 Union Blvd.
Casper, WY 82601

Team Leader:

Following are additional comments on the Draft Environmental Statement for Eastern Powder River Coal, as were promised at the ES hearing in Casper.

1 Concerning uranium production levels and schedules, the ES Team would do well to obtain a copy of Mineral Development Monitoring System, a recent publication of the Minerals Division of Wyoming's Department of Economic Planning and Development. The report is an attempt to survey probable mineral development in Wyoming for each county and active company, and as such gives a useful oversight. However, the section on uranium does not catalogue all possible or probable developments. The section on coal makes no mention of NERCO's new proposed mine in Converse County. I stand by my testimony on probable new uranium mines for the near future, except that one of the possible open pit mines reported for the Pumpkin Buttes area should have been counted as a solution mine.

2 I am concerned that the ES is supposed to assess significant impacts of cumulative energy development on towns outside of the study area, yet does not address the problems of Midwest, Edgerton, and Kaycee. These towns should all experience impact from expanded uranium development in the Pumpkin Buttes area. I suggest that the ES Team discuss the situation with local governmental officials and planners, as well as with social service representatives from Natrona and Johnson Counties.

3 As promised, here are some names of ranchers in the immediate vicinity of uranium exploration and mining activity who have experienced well problems. I am sorry that I cannot document more, for my records are quite sketchy and I have not attempted to do anything like the exhaustive study which should be done. From my limited contacts in Campbell County, I found that the following ranchers have had problems: Albert Schlautmann, John Christiansen, Charles Christiansen, and Leroy Van Buggenum. In Converse County, Gene Hardy and Richard Hornbuckle have had problems as well as others who prefer to remain unnamed. There are doubtless others in both counties who have experienced declining yields, flowing exploration holes, lowered artesian pressure, and contamination of potable aquifers.

4 Other impacts of uranium mining and milling have not been adequately addressed. For example, participants (including myself) in a Congressional tour of the Powder River Basin (staged this July by the Colorado School of Mines and Resources For the Future) discovered that Selenium-converter plants are growing on reclaimed land at Exxon's Highland Uranium Mine. Questions remain concerning the seriousness of the situation and the probability of it occurring at other sites. The Morton Ranch Statement states that moderate to high levels of Selenium are associated with overburden at the Morton Ranch sites, which indicates a strong possibility that the Selenium

-2- 26

problem may develop there, also. Elevated concentrations of Se in both sagebrush and lichen were found by the U.S. Geological Survey near the Dave Johnston power plant, raising questions about levels of Se in grasses. (See "Geochemical Baselines," U.S.G.S. Circular 778, 1978, p. 27-28.)

5 Other trace elements may produce geochemical impact for vegetation, livestock, and wildlife. The U.S.G.S. Circular cited above also addresses altered Cu/Mo ratios for vegetation growing on strip mined lands in the Northern Great Plains, and other geochemical parameters. The ES does not adequately assess their potential and probable impacts for coal and uranium strip mines and power plants.

6 Other impacts of uranium mining and milling have been touched upon or hinted at, but not addressed in detail. They include, but are not limited to: the affect upon groundwater tables of not re-injecting water from deep mine de-watering operations, both on a site-specific and cumulative regional basis; the potential and probable solution mining impacts; the potential Selenium, Radium, and Radon problems with tailings ponds versus in-pit burial of tailings; and, the cancer rates in uranium mining areas. These impacts should be assessed for the region (and contiguous areas) and for a typical site. I would suggest Exxon's Highland Uranium Mine for the latter, as it has a mill and strip, deep, and solution mine projects in one location, and has been operating for some time.

7 In summary, the Draft ES does not give a true picture of the cumulative regional impacts of energy development in the Eastern Powder River Basin, and largely because of its failure to address uranium development in any kind of depth. Its value as a decision document is substantially diminished for this and other reasons. The Powder River Basin Resource Council has supported the cumulative regional impact assessment of all mineral development, and reiterates its support for this concept now.

Thank you for the opportunity to comment.

Sincerely,

James V. Resick

James V. Resick, Douglas Staff
Powder River Basin Resource Council

Letter 26 Responses

1. The team used the Mineral Development Monitoring System (DEPAD 1978) as a source for correcting uranium development information throughout the text, most notably in Chapter 1 and the socioeconomic portions (projected population increases). For reasons explained in transcript response #4, changes in coal development projected for the region have not been made.

2. This ES was prepared to analyze impacts of coal development in the Eastern Powder River Basin. It is felt that most population increases due to coal development will occur in Gillette, Douglas, Wright, and communities east of Gillette. The impacts of uranium development are discussed as a part of the cumulative regional analysis rather than in detailed terms.

3. Thank you for the information. Hydrologic problems posed by uranium development are recognized but, admittedly, not well described. A recommendation for study is being prepared for the Director of the Geological Survey at the Survey's National Center in Reston, Virginia. The Bureau of Land Management and other agencies have been asked for their input to the recommendations.

4. An addition has been made to the text in Chapter 4 of the regional analysis, Vegetation.

5. See response 17-1.

6. This ES was prepared to analyze the impacts of coal development in Campbell and Converse counties. The increase in uranium mining activity, population increases attributable to uranium development, water usage, air quality impacts, and so forth are described as a part of the cumulative regional analysis.

7. See response 26-2.

27

UNITED STATES DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
P. O. Box 2440, Casper, Wyoming 82602

December 12, 1978

Mr. Daniel Baker, Director
Bureau of Land Management
P. O. Box 1828
Cheyenne, Wyoming 82001

Dear Mr. Baker:

My staff has reviewed the Draft Environmental Statement for the Eastern Powder River Coal Region. We have no comments other than we thank you for the opportunity to participate in the review process.

Sincerely,

Frank S. Dickson
State Conservationist
acting

Letter 27

No response required.

28

CHAPTER I - DESCRIPTION OF REGIONAL DEVELOPMENT ACTIVITY

Regional Development Summary

1 "The high level of coal development (329 million tons annually by 1990) represents the addition of potential new coal development to the probable level."

Comment: This level is totally unrealistic in view of factors such as coal demand, economic conditions, diligent development, lack of a federal leasing policy, taxes, and legislation. As to coal demand there is e current "softness" in the market due to e number of factors including delaya in power plant construction and energy conservation.

The Department of Energy, empowered by Congress to develop diligent development criteria and regulations under tha Federal Coal Leasing Amendments Act of 1975 presently requires thet on existing leases the coal resource be mined at a rete of 1/40ch of the leasehold per year beginning in 1986. With the number of statutory and regulatory delays for mine approvals plus marketing conditions likely the numbers will be at a lower level. The other problem areas all contribute to a lesser demand on the coal resource. A more realistic figure is advised. By placing a figure so high only invites unnecessary criticism and does not adequately address "probable impacts", a requirement of NEPA.

Levels of Coal Production

2 Table R1-2, Eagls Butte 5.8 million tons 1978 is incorrect. Eagle Butte is now forecast for 300,000 tons in 1978 and 3-4 million in 1979, 1980 and thereafter is accurate. Construction start up for Eagle Butte was 1976. For Belle Ayr 18.5 is realistic for 1978, 20.0 for 1979 and thereafter. There are other corrections to this such es Caballo which is producing now and Cordero which will likely not be near 9.2 million tons in 1978.

3 Comment: Table R1-2 Federal coal areas for Belle Ayr appears to be incorrect. The proper number is 2440 acres.

4 Table R1-2 (continued page R1-8) 211 Permanent employees at Eagle Butte appears to be high. 30 employees 1978, 103 in 1979, 200 in 1980.

5 Page R1-4 and 10 Coal Gasification Plant

Comment: The timetable here appears to be unrealistic in view of financing and permitting difficulty.

6 Page R1-13 Table R1-3. "Number of coal mines 11-1978 and 15-1980 thereafter."

Comment: 10 is a more accurate number and 15 appears too high.

7 Page R1-18 Table R1-7 Water Requirementa for Development. "Mine Operation 20 A-F per million tons coal".

Comment: This appears to be too high. In our experience in the Powder River Basin little if any water ia needed. Pit water is used for dust suppression, the remainder from wells would be used for drinking and sanitary facilities.

28

AMAX COAL COMPANY
A DIVISION OF AMAX INC.
1800 POLY DRIVE—SUITE 185 (406) 252-3891 BILLINGS, MONTANA 59102

December 11, 1978

Mr. Dan Baker
State Director
Wyoming State Office
Bureau of Land Management
P. O. Box 1808
Cheyenne, WY 82001

Dear 'Mr. Baker:

AMAX Coal Company wishes to submit written testimony to che Draft Environmental Statement Eastern Powder River Coal. The document which was subject to public hearinga in November overall is a good effort in compliance wich environmental requirementa and court decisions. The comments we offer are intended to be constructive and to make the document atronger and more accurate.

Should you have further questions on our comments, please so advise.

Sincerely,

Thomas E. Ebzery, Manager
Government Relations West

mm
Enclosures

-2- 28

Chapter 2

Description of the Environment

Page R2-29 Alluvium

8 Paragraph 3 which discusses alluvial valley floors contains references to studies which are either discredited or tha mapping done did not pertain to the 1977 Act. This section should be rewritten explaining that guidelines have been developed to both identify valley floors and to suggest restoration of tha hydrologic balance.

Page R2-42 Silver Sagebrush

9 "The silver sagebrush shrub community is found on level to gently sloping floodplains of atreams which during at least part of the growing season, or on land which receives additional water from overflow."

Comment: This atatement implies that silver sage is only found where irrigation or subirrigation is present. It is found everywhere in the Powder River Basin and with no evidence of irrigation or subirrigation in many instances.

Page R2-71 Farming

10 Paragraph 7 "Prime Farmland is probably present in the region, but is expected to be a minor component of the agricultural lands. No formal designation of prime farmland has yet occurred in the region."

Comment: Suggest that the Soil Conservation Service, the duly authorized agency to designate areas has determined that no prime farmland areas exist in the area. This should replace tha atatement thet prime farmland is probably present in the region.

Page R2-86 Air Service

11 Paragraph 6 - This should be rewritten to reflect tha construction additions to tha Gillstte airport that have taken place. Also additional commuter lines have been added.

12 R2-88 should be redrawn. Western has discontinued service from Sheridan to Casper and Cheyenne.

Page R2-92 Area Development and Growth

13 Comment: This data presented in this section should be checked thoroughly to be certain that it reflects the most recent survey data availabls. The City of Gillette/Campbell County Citizen'a Policy Survey is taken twice each year, and there is additional data evailable. As to the aurveys themselves, have they been professionally taken? Suggest they be added as appendix material.

Table R2-26 Average Wage & Salary Income

14 Comment: This appears to be dated information, particularly regarding mining.

R2-III Local Services

15 Comment: The 1978 Wyoming Legislature provided for loans from the Wyoming Mineral Trust Fund and other sources to construct a series of pipelines to bring water from the Madison Formation. (HB76A) This is a significant breakthrough for citizens of Gillette and should be fully discussed including a solution to the chief citizen complaint in the 1977 survey.

Page R2-102 Table R2-23

16 Comment: The population figures should be reviewed and changed. The figures given for Gillette and Campbell County are certainly too low, and it may well be that the figures for other cities and counties are also. Suggest that local planning authorities be consulted to help in this area.

Page R2-24 Table R2-24

17 Comment: Suggest that the table be brought up to date with data available from local Chamber of Commerce Offices. In an area growing as rapidly as this, a document of this sort should present the most accurate data available. More accurate survey figures are definitely available from Campbell County Chamber of Commerce Office.

R2-127 Finances

18 Comment: 1. There is no discussion of the Coal Impact Tax enacted in 1975 and is 2% of the value of gross production. The tax is available for grants or loans to communities impacted by coal for sewer, water and highways.

2. Severance Taxes - "State severance taxes are 8.5% of the value of gross production. These taxes accrue directly to the state and are not returned to communities." A breakdown of the tax would be appropriate, e.g., coal, oil and gas, trona and where the taxes go.

Page R3-5 Air Quality

Paragraph 1, Column 1

"No mandatory Class I areas are within the Eastern Powder River Basin. The nearest mandatory Class I areas are Grand Teton and Yellowstone...."

19 Comment: The discussion concerning the Class I, Class II and Class III areas should be rewritten in order that the Powder River Basin situation is more accurately reflected. While it is true that the nearest mandatory Class I areas are located at Grand Teton and Yellowstone National Parks, there are additional areas, not included on the mandatory list, which presently do receive or may receive in the future, the protection of Class I. The Northern Cheyenne Reservation presently does have Class I status. Devil's Tower national monument, about 40 miles northeast of Gillette, is being studied by the National Park Service for possible Class I status.

Page R3-5 Water Quality

20 Comment: A status report on the 208 Program would be appropriate.

Page R3-7 Coal Impact Tax

21 Comment: Delete and insert proper language. This is incorrect. As mentioned in earlier comments, this Act was passed in 1975, is mandatory until 100 million is raised.

Page R3-7 Local Sales Tax Option and Joint Powers Act.

22 Comment: Both of these acts were passed in the 1970's to provide other outlets for raising money for impact purposes. Wyoming's Constitution does not provide for debt and the above acts were specially designed to fall within the Constitution and allow for assistance to communities. There should be more than one or two sentences describing these statutes as they have a significant bearing on the future of the Eastern Powder River Basin.

Page R3-9 Local Planning

23 Comment: As has been commented upon earlier, the Land Use Plan was approved by both the City Council and County Commissioners in 1978, then submitted and approved by the Land Use Commission in fall 1978. There is no ban on mining within 3 miles of the City of Gillette. It is suggested that Section K be reviewed and this section be rewritten incorporating the final version.

Page R3-11 State & County

24 DEQ - Comment: The agreement was signed in October 1978.

25 Table R4-1 - Page R4-2 - AMAX believes if this information is to be considered accurate, it should go to much more detail in explaining the methodology and the sources.

26 R4-5 - Population Table R4-3 - These figures are suspect and be rewritten.

27 Page R4-25 - "The removal of vegetation from stripping areas, access roads, the main rail line, rail spurs, and its destruction under piles of overburden would lead to increased use of remaining vegetation by livestock and wildlife".

Comment: This statement is exaggerated and considering how few temporary acres are disturbed and balanced against productivity increases on the reclaimed land make the statement unnecessary.

Page R4-25

28 Comment: Under the heading AMAX Coal Company (Belle Ayr Mine) the final five paragraphs should not fall under this heading as they are generalized statements on revegetation. A new headnote should follow the statement: "more data on reclamation results will become available as the results of current studies are published."

29 Page R5-2 Paragraph 3 - This is a conclusion and stating that TSP standards may be exceeded at the mine boundaries indicates no source for such a conclusion and use of such a statement is not warranted in this statement.

Chapter 7 Irreversible and Irretrievable Commitments of Resources

30 Comment: This entire chapter is marked by statements not supported by even reasonable facts. It appears to be mere speculation by the authors. For example, "The traditional lifestyle of towns and counties in the region would undergo additional integration with newcomer's lifestyles. By 1990, newcomer's lifestyles would likely predominate."

Comment: There is absolutely no foundation for such a statement. This is highly unlikely as the growth in the region will be fairly steady with a

30 solid agricultural base. A statement such as this does a disservice to present and future residents of the region.

Chapter 8 Alternatives

Regional Alternatives - "To date the Wyoming Department of Environmental Quality has not released any area as being satisfactorily reclaimed."

31 Comment: An explanation should be made here. The Wyoming Environmental Quality Act was not passed until 1973 and the statute does not provide for bond release until a minimum 5 years from completion of reclamation. This should explain why bond release has not been achieved.

Page R8-4 Table R8-1

32 Comment: Figures for Eagle Butte are too high and Belle Ayr should be 18.5 in 1978. In 1979 Belle Ayr should read 20.0 and Eagle Butte 3.0-4.0 million. I also suspect that Cordero is high. Caballo has 1978 production.

Page R8-9 Table R8-2 "No. of Gasification Plants - 1"

33 Comment: This does not seem realistic.

Page R8-27 Paragraph 4

34 Comment: The paragraph refers to ground water supplies used in conjunction with gasification and makes assumptions which should be reviewed.

Page BU2-12 Water Resources - Ground Water. "The presence of unconsolidated stream laid deposits containing groundwater indicates hydrologic conditions within the definition of 'alluvial valley' floors are present."

35 Comment: Section 701 of P.L. 95-87 is a complete definition of what an area must possess to be considered alluvial valley floors. Section 510(b)(5) of the same act provides requirements or exclusions (such as undeveloped rangeland) from obtaining permits. This is not discussed and should be if a statement that valley floors do exist is to have any credibility.

Letter 28 Responses

1. There are, as noted in the ES, many factors which could affect future rates of coal production. Our production scenarios are based upon our best judgment after consideration of all available and relevant information.

2. Information for the Eagle Butte and Belle Ayr mines has been corrected in the relevant tables and portions of the text. According to Bill Stone, Carter Mining Company, production at the Caballo Mine in 1978 was approximately 145,000 tons (fee coal), and this additional production has been inserted in the appropriate tables. Other data for Caballo and all data for Cordero were taken from the company-submitted mine plans, dated September 1977 and December 1976 respectively.

3. The tables in Chapters 1 and 8 of the regional analysis have been corrected.

4. The tables in Chapters 1 and 8 of the regional analysis have been amended.

5. Information about the gasification plant was drawn from company plans and personal contacts.

6. Since neither the Coal Creek nor the East Gillette Mine began construction in 1978, the number of mines in 1978 was 10. The text has been changed accordingly. However, by 1980 all 15 mines are expected to be operating or under construction.

7. Water use for individual mines showed wide variation, necessitating an average use figure, which was found to be 20 acre-feet per million (A-F/MM) tons of coal produced. This figure was derived from water use data contained in three mining companies' mining and reclamation plans (M&RPs) and two GS environmental statements on file at the Casper BLM District Office, and from personal communication with Karl Starch, Bureau of Mines 1978. M&RP and ES data ranged from 16 to 25.8 A-F/MM tons with an average water use of 20.2 A-F/MM tons. Bureau of Mines data for four mines ranged from 6.7 to 70 A-F/MM tons with an average water use of 23.2 A-F/MM tons. Overall average for nine mines was 21.7 A-F/MM tons of coal produced.

8. Although the mapping was done before the Surface Mining Control and Reclamation Act was passed and does not have the detail of the proposed guidelines published in the Federal Register, August 25, 1978, the maps are pertinent to the identification of alluvial valley floors. It is recognized that on-the-ground study and mapping will be necessary in many cases before the existence or absence of alluvial valley floors can be established.

9. The statement has been changed to indicate that silver sagebrush is also found in other areas. See Chapter 2 of the regional analysis, Vegetation.

10. According to the latest information that is available, the Soil Conservation Service has not yet made a determination that no prime farmland areas exist in the region. The situation has not yet been resolved.

11. The text has been revised. See Chapter 2 of the regional analysis, Transportation Networks.

12. The figure has been corrected.

13. At the time the draft ES was written, the 1977 Citizens' Policy Survey was the best information available. Since that time, a 1978 survey has been released. It indicates that citizens have substantially the same major concerns that they did in 1977. Therefore, although the text now notes the existence of the new survey, extensive changes in results have not been made.

14. This information is intended to illustrate relative changes in wages and salaries, and is still valid for this purpose.

15. This information has been added to the text of the site-specific analysis, Chapter 2, Socioeconomic Conditions, Water Supply.

16. This is a valid observation, and the appropriate changes have been made throughout the text.

17. For the purpose of comparing all impacted communities, it was decided that the sectoral employment for the various counties would be based on a common data source. In this case, the U.S. Department of Commerce, Bureau of Economic Analysis 1977 (Local Area Personal Income, 1970-75) was chosen.

18. The coal impact tax is discussed in Chapter 3 of the regional analysis, Severance Taxes. The disposition of the coal severance tax is also shown here.

The text in both Chapters 2 and 3 has been revised to show a tax on coal of 10.1%.

Since this is a coal ES, a breakdown of severance taxes for other minerals is not included in the text. It is as follows:

Severance Tax Distribution, 1978
(Excluding Coal)

	Trona	Uranium	Oil and Gas
Permanent Wyoming Mineral Trust Fund	2.0%	2.0%	2.0%
General Fund	2.0%	2.0%	2.0%
Capital Facilities Revenue Account	1.5%	1.5%	___
TOTAL	5.5%	5.5%	4.0%

Adapted from: Wyoming Department of Economic Planning and Development, 1978 Yearbook.

19. An addition has been made to the text in Chapter 3 of the regional analysis.

20. Currently, a 208 plan is being completed for Johnson, Sheridan, and Campbell counties. It is undergoing state certification review. Water quality impacts of mining are a major emphasis of this plan.

No plans have been developed for Converse, Natrona, Carbon, Albany, Platte, Goshen, Laramie, Fremont, or Sublette counties. These will be completed by 1983, as federal funds become available. Energy development impacts will be addressed in great detail. (Status report supplied by personal communication, Carolyn Dinger, Water Quality Division, DEQ 1979.)

Additions have been made to the text in Chapter 3 of the regional analysis.

21. The text of Chapter 3 has been revised.

22. Our purpose is to point out the availability of various revenue-sharing and taxation methods, not to provide detailed information.

23. The Cooperative Planning Program, City of Gillette/Campbell County, was adopted by the City of Gillette on July 17, 1978, and by Campbell County on July 18, 1978. It was approved by the Land Use Planning Commission of the State of Wyoming on August 27, 1978. The text has been revised to reflect the final approved version of the Cooperative Planning Program. See Chapter 3 of the regional analysis.

24. The text has been amended.

25. The source of the information in Table R4-1 is the Radian (1978) study contracted by BLM for this ES. The study explains the derivation of the information given in Table R4-1. It is available for public review at the BLM Casper District Office.

26. Table R4-3 has been corrected.

27. Until such time as disturbed lands are reclaimed to livestock use at a much greater rate than at present, it is inevitable that the remaining vegetation will receive increased use. The Wyoming Department of Agriculture shares this concern (see letter 35).

28. The text has been corrected.

29. The statement in question has been deleted.

30. Given the fact that the agricultural sector will decline in relative importance, as measured in terms of employment and income, it is not unreasonable to assume that the agricultural life-style will decline as a proportion of all life-styles in the region.

31. The text has been changed to explain one reason why no areas have been released as yet. See Chapter 8 of the regional analysis, Regional Alternatives, Defer Future Federal Coal Development.

32. See response 28-2.

33. Many possible coal gasification projects have been discussed at various times in recent years. However, we have no recently updated, firm proposals for the region. On the basis of information we do have, we feel one plant is a reasonable projection within the 1990 time frame.

34. The amount and sources of water required for the gasification project are described in the company's plans (SERNCO 1974). Reference in the ES is only to groundwater sources being considered for use. The sources considered are correct as stated.

35. The definition of alluvial valley floors from P.L. 95-87 is given in Chapter 2 of the regional analysis, Water Resources. This definition is one of the tools used to identify alluvial valley floors. Whether or not an exclusion might apply in an individual case is a separate question.

29

BURLINGTON NORTHERN

Frank S. Ferrell
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Shirley A. Birmingham
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Attorneys

Team Leader
Coal E.S. Team
951 Union Boulevard
Casper, Wyoming 82601

December 22, 1978

Re: Draft Environmental Statement - Eastern Powder River Coal (Your File 1792 (920))

Dear Sir:

Burlington Northern Inc. submits the following comments on the Draft Environmental Statement (ES) for Eastern Powder River Coal.

Development Projections

1 The draft ES has evaluated future coal production at three projected levels - probable, low and high. Although the "low" and "probable" demand projections are not outside the realm of reason, the "high" projection challenges belief. All estimates must be tempered with the realization that production of - and demand for - Powder River Basin coal depends on a number of factors related to the competitiveness of this region's coal vis-a-vis other fuels as well as coal from other regions in the U.S. There are a number of developments currently in the offing which are now significantly tipping the competitive balance away from Powder River coal and may well reduce drastically even the "probable" scenario.

Among these developments are laws pertaining to pollution-control, especially the "best available control technology" regulations currently being formulated by the Environmental Protection Agency (EPA) as a result of the 1977 amendment to the federal Clean Air Act. The proposed regulations would require that all new coal-burning power plants be required to install expensive scrubbers to remove at least 85 percent of the sulphur dioxide produced. This requirement would apply regardless of the sulphur content of the coal being used. The legislative history of the Clean Air Act suggests to some that it was the intention of the Congress to foster the production of eastern coal from underground mines at

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1 the expense of western surface mine production despite the fact that now the cheapest way for many utilities to reduce sulphur emissions is to use low sulphur coal from the latter source. If the new regulations go into effect, however, the attractiveness of Powder River Basin coal will be sharply diminished as higher-sulphur "local" coals could be used for mine mouth generating plants or would not have to be transported as far to the power plant. This in turn would no doubt result in major curtailment of planned mine expansion and new openings in the western regions. The precise extent of this shift in fuel sources is not predictable until EPA settles on final regulations which it is required to promulgate no later than March 12, 1979 by court order. If they are comparable to those now proposed, the effect on western production will be severe. Burlington Northern has filed a submission with EPA, attached, which gives the problem perspective. It is in the form of a statement by our Mr. A. E. Michon and an accompanying technical paper prepared at our instance by Teknekron, Inc. This material is based on computer programs which take into account the variables represented by such factors such as prices of coal from most major sources, the capital costs enacted in constructing scrubbers, their operating expenses, coal transport costs, and so on. While the purpose of the papers is to demonstrate to EPA that the proposed standards are not legally required and are inappropriate in the national interest, they also provide measures of the effect of those standards. Moreover, they illustrate the manner in which, if adopted, those standards will circumscribe the market for Powder River Basin coal.

Legislation and regulations restricting the surface mining could also reduce production from the Powder River Basin. The Surface Mining Control and Reclamation Act of 1977 provides stringent guidelines governing surface mining of coal. These may well serve to restrict mining activities. Until implementation of regulations and state programs are established, it is not possible to predict what effect this Act will have on western coal development.

Another potentially restrictive development is the recent proposal of the U.S. Department of Transportation that a fifty-cents-per-ton surcharge be added to coal prices in order to help pay for (1) highway reconstruction in Appalachia to facilitate coal haulage and (2) rail-highway crossing improvements. If enacted into law, this would place a disproportionate burden on lower-priced western coal because of its relatively lower BTU-per-ton yield, and would affect the competitive price relationships with coals from other regions.

1 As stated, further development of Powder River Basin coal is strongly dependent on its competitive relationship with coals with a higher BTU content or from regions closer to major markets. This relationship can be sharply altered by new technology in mining and in fuel burning processes, by improvements in the availability of other energy sources and by new laws and regulations which are being developed and implemented. Any projections, especially those beyond 1985, should recognize these high potentials for diminution in production.

Projected Rail Traffic

2 The impacts attributed to rail operations in the region are overstated throughout the draft ES. Most rail traffic will consist of unit coal trains whose number will be directly related to coal production and the location of coal consumption. The number of daily unit trains was calculated based on a 100-car train* with capacity of 10,000 tons. In actuality most unit trains are comprised of 110 cars giving a train capacity of 11,000 tons. The effect of calculating the number of unit trains based on the shorter 100-car train is substantial. In Table R4-10, page R4-38, for example, the 1980 daily average number of unit coal trains eastbound is given to be 28.4. Using a 110-car train, the number drops to 25.8** per day, a reduction of 949 trains per year. Moreover, if the demand for western coal softens for reasons suggested above or if a greater percentage of the coal produced is consumed in the Powder River Basin because of changing regional demands, the number of unit coal trains will be reduced accordingly.

3 In estimating growth in coal unit train traffic the increase as a percentage of current traffic is overstated. This can be traced to two factors. First, the number of trains is inflated by a factor of approximately 10% based on the 100-car unit train. Second, the number of present coal unit trains is understated. For example, 1978 coal traffic is stated to be 60 unit trains per week (one way). D.E.S., page R5-1, third paragraph. Burlington Northern's operating records show that

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* See Table R1-2, pages R1-8 and 9; Table R2-17, page R2-81; Table R4-10, pages R4-37 and 38; Table R8-1, pages R8-7 and 8; Table R8-11, pages R8-32 and 33; Table R8-21, pages R8-48 and 50; Table R8-32, pages R8-77.

** 28.4 trains × 100 cars ÷ 110 cars = 25.8 trains.

3 nearly 75 unit coal trains are now operated each week between Donkey Creek, Wyoming and Alliance, Nebraska. This discrepancy exaggerates the effect on the environment and communities attributed to rail operations in those cases where changes are expressed in terms of percentage increases in present operations.

4 Changes in projected rail traffic volume will also affect predictions of rail line capacities. The draft ES states that current capacity of BN's main line from the Eastern Powder River Basin is 40 to 65 trains per day. D.E.S., page R2-78. Current traffic is computed to be 40% to 60% of this available capacity. Misstatements of current traffic volumes and anticipated traffic growth grossly underestimate the ability of rail carriers to transport the coal to be produced in this region. The draft ES also ignores steps which can be and are being taken to increase line capacity, including installation of CTC systems, adding sidings and completion of the Gillette-Douglas main line, all scheduled for 1979.

5 Apart from the deficiencies in the study attributable to uncertainties as to production volumes, another basic problem lies in the fact that no attention is given to the fact that even existing coal traffic may be divided between rail carriers and then diverted to routes different from those which have been considered. Specifically, the Chicago and North Western Transportation Company has sought a Federal loan guarantee from the Department of Transportation by which to finance the rehabilitation of its route between Shawnee, Wyoming and Fremont, Nebraska at a cost of $532 million. 43 FR 41126 (September 14, 1978). While that application is still pending, announcement has been made that that company and the Union Pacific have agreed that they will collaborate in the development of a substitute, entirely new rail route connecting a point east of Shawnee, Wyoming and the Union Pacific line between Torrington, Wyoming, and O'Fallons, Nebraska. This would allow the movement of coal to markets in the east and southwest over a combination of routes of the two railroads. See clipping attached. If these plans become a reality, large volumes of coal traffic will be diverted from BN routes to C&NW-UP and the basis for the draft ES as it applies to rail transportation will be entirely wrong.

Impact on Communities From Unit Trains

6 Impact on communities along rail lines will not be nearly as great as was suggested by the draft ES for several reasons. As described above, the projected number of unit trains is inflated at a minimum by a factor of nearly 10%.

It should also be understood Burlington Northern has taken and will further pursue steps to minimize the adverse affect on major communities through which its line passes. Following is a brief summary of some of those specific measures already taken.

Sheridan

BN operating personnel are working with the yard and train crews to keep the crossings open as much as possible. This is a continuing process.

Gillette

6 The State of Wyoming has recently completed an analysis of various possible locations for an overpass and has submitted this analysis to the city for its further handling. Additionally, an existing grade separation of U.S. Highways 14-16 is to be widened and at the same time a second track separation will be constructed. The second track over the highway will relieve congestion at Gillette to some extent and thereby reduce the time that crossing is occupied. Again, operating personnel for BN are constantly working at reducing delays at crossings due to switching operations and movement of through trains.

New Castle

CTC installation had eliminated some of the problems associated with trains being delayed while waiting for opposing trains to clear as has the extension of the sidings in this area.

Grand Island

Present train traffic through Grand Island averages 18 trains per day, not 22 as stated on page R2-84. BN's operating department has taken several steps to reduce delays at the crossings. BN trains are being held short of grade-crossings until it is known that the Union Pacific crossing is clear. Further improvement can be expected in this area as BN radio communications equipment is being installed at the Union Pacific interlocking tower for direct communication with BN trains. Currently there is a 10 mile per hour train order on the UP crossing on the BN track due to track conditions. This condition will be corrected in the spring with the installation of new crossing diamond.

29

Team Leader -6- December 22, 1978

While there will be an increase in unit coal train traffic, the character of this type train operation must be kept in perspective. Unit trains are generally less noisy, less obstructive and less hazardous than conventional, general commodity trains even though, by reason of the sameness of the equipment, they present a unique and massive appearance. As stated, a coal unit train consists of approximately 110 similar cars and three to five diesel locomotives. The entire train moves as a unit from mine to utility and back again without stopping and switching except for emergencies or at crew change points. They represent rail transportation at perhaps the highest
7 level of efficiency. Yet unit trains are often shorter than other trains and operate at moderate speeds which minimize hazards at grade crossings. They usually travel about 45 miles per hour and thus block a crossing for only 90 seconds.*

In contrast, general commodity trains may consist of 150 or more cars of various kinds, both loaded and empty. Since they employ a variety of equipment, they are noisier than unit trains and since they carry time-sensitive freight, they operate at speeds up to 60 miles per hour. Yet, except for manifest trains, they must also pick up and set out cars for shippers along the line and, therefore, sometimes cause delays and conflicts at grade crossings. By any standard, a coal train is less disruptive of the communities through which they pass than are most freight trains.

8 It is also highly misleading to aggregate periods to highway traffic interruption so as to conclude, as does the ES at page R2-78, for example, that "A railroad crossing is impassable for an hour and 15 minutes per day at 20 miles per hour and for 5 hours per day at 5 miles per hour." The same logic requires a conclusion that at any signalled street intersection each street is impassable 12 hours per day. The only significant measure obviously is the duration of individual interruptions. It is perhaps also appropriate to point out that the measurement of problems associated with grade crossings concern perceptions as opposed to reality. Thus it is appropos to point out that while concern is expressed as to Burlington Northern's new operations, for many years Union Pacific has operated 60 or more trains daily through the same general territory here under consideration without substantial complaint as to safety, environmental or other effects.

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* The examples in the draft ES calculate crossing blockage time for only very slow speeds. See pages R2-78 and R4-36. These yield unrealistically high estimates of crossing blockage due to unit trains.

29

Team Leader -7- December 22, 1978

Coal Slurry Pipelines

9 The draft ES makes only passing reference to slurry pipelines because no adequate application for right-of-way for the pipeline is currently on file. (See page R1-11.) This cavalier treatment is hardly justifiable in a presentation which undertakes to forecast such nebulous subjects as coal demand and the effects of coal demand in 1990. Slurry line proponents themselves represent that slurry line construction is a certainty in the early 1980's.

In light of the serious environmental risks posed by slurry pipelines - especially the diversion of Wyoming's scarce water resource - and the relative ease of filing an application, careful treatment of these environmental impacts seems required. It will not be our purpose to deal with this subject, but refer the Bureau to the report of the Office of Technology Assessment on slurry pipelines. Office of Technology Assessment, TASK REPORTS, COAL SLURRY PIPELINES (January 1978). Reference should be made in particular to the environmental consultant's report as set out in Volume II, Part 2, Task Report No. III in that study.

Other Considerations

10 It is certainly appropriate to point out also that the operation of a railroad as a transportation instrumentality produces important environmental and other benefits. Not only is employment made available in territory where jobs are scarce, but other large economic benefits result. The making of low sulphur coal available to generating stations both within and beyond the region is a vast contribution to the improvement of air quality. The final ES would be grossly incomplete should it fail to emphasize that western coal development had its genesis in the need to preserve and improve the national environment and that such sacrifice as there may be in the region is greatly outweighed by these larger considerations.

Conclusion

11 In light of our comments above, especially regarding the uncertainty of demand for western low sulphur coal and failure to adequately review environmental impacts of slurry pipelines, it appears that this attempt to prepare an environmental statement on the entire Eastern Powder River Basin is premature. To be sure in a situation of this kind at least some change is always in prospect. Yet we suggest that the Bureau would be well advised

29

Team Leader -8- December 22, 1978

11 to limit its statement at this time to impacts from the Buckskin Mine and to postpone its regional analysis. A final ES for the region based on the draft ES cannot claim to accurately portray environmental impacts on the region in light of the very great immediate risk of major changes in the subjects under review.

Respectfully submitted,

James R. Walker

James R. Walker
General Counsel

JRW:DBF:4-11

Attachment

Letter 29 Responses

1. The concerns pointed out in this comment are certainly relevant: some which involve national considerations are discussed in the draft ES on the Federal Coal Management Program (December 15, 1978); others are very speculative. The production scenarios used in this ES were based upon our best judgment after consideration of available information.

2. The Wyoming Highway Department (1977) states that the average load per car is approximately 94 tons, which means that a 110-car train would still haul approximately 10,000 tons. Therefore, both the hypothetical 100-car train loaded with 100 tons per car or the 110-car train loaded with 94 tons per car would move approximately the same tonnage. This being the case, the number of trains comprised of 110 cars would be the same as the ES calculates for the 100-car train. The result of using the 100-car length train in the ES actually reduces the time crossings are blocked. Rather than recalculate the blockage time based on the same number of longer trains, we stand by our previous assumptions.

3. For the first part of the comment, refer to response 29-2. As to the second portion of the comment, refer to Table R2-25 where it is shown that the segment between Donkey Creek and Alliance averages nearly 75 one-way unit coal trains per week. The segment that is discussed in Chapter 5, however, covers the segment from Donkey Creek to Grand Island. This averages out to about 62 one-way unit coal trains per week. The text has been clarified.

4. The range of 40 to 65 trains per day was given to account for additional capital equipment that would likely be installed during the first year of analysis. Because this particular section of Chapter 2 is concerned with the existing environment, planned changes that are not currently underway are not discussed.

As to the current traffic volumes, refer to responses 29-2 and 29-3.

5. The fact that Chicago and North Western (with the collaboration of Union Pacific) is planning to upgrade and/or construct alternate routes has been added to the text in Chapter 1 of the regional analysis. Because these plans are tentative, no change in impact analysis is required. Prior to approval of any right-of-way application for new construction, a separate environment assessment, including impacts to Burlington Northern's rail traffic, will be done. (The Department of Transportation, Federal Railroad Administration, is the lead agency for preparation of the environmental analysis on this action.)

6. For the comment on the number of unit trains, refer to response 29-2.

To the extent that planned changes are currently funded and underway, they have been included in the narrative, Chapter 2 of the regional analysis. The description of conditions in Sheridan and Gillette is considered accurate. The installation of the CTC system in Newcastle has been included in the narrative. Train traffic on the BN line in Grand Island is based on actual counts by Dave Wheeler, Switch Master for Union Pacific. The additional capital items mentioned in your comment have been included in the narrative.

7. The statement recognizes that the speed of a unit train traveling in open country may reach 50 miles per hour. It is pointed out, however, that speeds through communities are much slower, which means that the corresponding intersection blockages are longer.

The ES merely presents an example of how speed affects the time crossings are blocked, especially when speed slows to around 5 miles per hour near switchyards.

Information presented in the ES about the amount of time crossings are blocked in various communities was obtained through interviews with local officials.

8. The example given in the comment would be appropriate were it not for the fact that the narrative points out the time that each train would block a given intersection, as well as the total time a given number of trains traveling at a specified speed would block that same intersection during a 24-hour period.

9. Energy Transportation Systems, Inc. filed an updated right-of-way application with the Bureau of Land Management in May 1978. The application is in the process of being perfected. Environmental impacts of the proposed slurry pipeline will be assessed in a separate ES.

10. The text has been amended to mention the positive impacts of increasing railroad employment and making low sulfur coal available to other regions. See Chapter 6 of the regional analysis.

11. Your point of view has been noted. See response 33-14.

Letter 30 Responses

1. The text in Chapter I of the regional analysis has been revised to include mention of the Sierra Club v. Interstate Commerce Commission lawsuit.

The rail transportation sections of this ES identify offsite (outside the region) impacts which pertain to the proposed action, as far as they are significantly identifiable. Some additions have been made to the text in Chapters 2 and 4 of the regional analysis.

2. Please see response 29-5.

30

DEPARTMENT OF TRANSPORTATION
FEDERAL RAILROAD ADMINISTRATION
WASHINGTON, D.C. 20590

ASSOCIATE ADMINISTRATOR

2 DEC 1978

Ms. Julie Elfing
Team Leader - Bureau of Land Management
Coal ES Team
951 Union Boulevard
Casper, Wyoming 82601

Dear Ms. Elfing:

We have reviewed the Bureau of Land Management's draft Environmental Impact Statement (EIS) on Eastern Powder River Basin (EPRB) Coal and suggest that the Final EIS include the following clarification:

1 1. The statement is made on page R1-10, "Rail service is provided via two main lines of Burlington Northern (BN) (principal rail service) and one main line of Chicago and North Western (C&NW). Upgrading of existing tracks is presently in progress. BN and C&NW are jointly constructing a major new rail line between Gilette and Douglas, portions of which are in operation." With regard to the "major new rail line," there is no mention, however, of the litigation, Sierra Club vs the Interstate Commerce Commission (ICC), and the decision to remand the case to the ICC for further information on the proposed joint new line. We understand that this Environmental Impact Statement is to be responsive to the decision. If this is so, it should be so stated and the implications of the decision discussed in the EIS.

2 2. In the sections beginning on pages R2-78, R4-36, and R8-78 there is discussion of rail transportation. The Federal Railroad Administration presently is considering an application for financial assistance to the Chicago and North Western Railroad Company which would permit them to participate in the carriage of Powder River Coal. If approved, this project would increase the capacity of the rail system serving the EPRB market as well as provide a competitor to the BN. The final EIS should include discussion of the socio-economic and environmental implications of C&NW participation in the coal movement as well as the implications of competition on regional coal production.

We appreciate the opportunity to review this EIS and look forward to receiving the final EIS.

Sincerely,

Ronald H. Reimann

for Steven R. Ditmeyer
Associate Administrator
for Policy and Program Development

31

Powder River Basin Resource Council
Sheridan, Wyo. 82801
150 W. Brundage
(307)672-5809

810 Richards
Gillette, Wyo. 82716
December 22nd 1978

Team Leader
BLM
951 Union Blvd.
Casper, Wyo. 82601

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT FOR THE EASTERN POWDER RIVER BASIN

These comments are a written recapitulation and clarification of oral testimony given in Gillette's Campbell County High School auditorium by Robert S. Anderson, a consultant for the Powder River Basin Resource Council.

These comments arise out of a concern for the overview of energy development in the Eastern Powder River Basin. It is felt that the Draft Environmental Statement (D.E.S.) is deficient in its analysis of overall trends, something which the general public ought to be able to extract relatively easily from such a statement. The included calculations are based on data introduced in various parts of the D.E.S., and on coal lease information published in a supplement to the Council on Economic Priorities'(C.E.P.) recent publication entitled Mine Control.

The two county area described in the D.E.S. is thought to contain roughly 73 billion tons of 'original mineable coal resources', of which some 30 percent, or 2 billion tons, is strippable. Something like 17 percent, or 3.7 billion tons, of the strippable

page 2 31

reserves are under lease to mines which are now operating in the two county area. Another 10 percent, making a total of 27 percent, is held by companies and operations included and enumerated in this report under the 'probable level of development' scenario.

A third and more revealing figure may be derived from inspection of the C.E.P. booklet entitled 'Coal Leasing' which accompanies the <u>Mine Control</u> publication. C.E.P. details the existing (i.e. issued) federal coal leases by county and acreage. Summing the acreages for the two county area considered within the Eastern Powder River Basin, a total of 102,500 acres is under issued federal lease. That is 160 square miles. Assuming a conservative tonnage of coal per leased acre of .1 million tons (calculated from mines presently in production), this total acreage represents some 10.25 billion tons of issued federal coal. That is, over 46 percent of the strippable coal reserves are under issued federal lease. Add to that all the coal under the state leases of school sections 16 and 36 -- all of which have been issued in the two county area (a total of 400 square miles) -- and to that the coal which has been leased privately, and it is demonstrable that well over half of the region's coal reserves are already leased.

With these figures in mind, let us look at the various scenarios for the mining of that coal which has been leased. The curves in figure R1-2 (page R1-5) were extrapolated using the slope of the last segment of the curves presented (the 1985-1990 slope). Taking areas under these curves, one may calculate total tonnages produced by a certain date -- cummulative production. Using the 'most probable' scenario, a total of 22 billion tons of coal (the full strippable reserve) will have been extracted

page 3 31

by the year 2090, slightly more than a century from now. But using the high level projection, these same strippable reserves will be gone by the year 2031, little more than fifty years away. We might add that the Department of Energy (D.O.E.) has come out with a statement which puts the expected (or requested?) production from the Eastern Powder River Basin at 500 million tons per year (that is, half a billion) by the year 1990. Note that this is fifty percent over the highest level scenario presented in this report (which shows production in 1990 to be 320 million tons). Using this D.O.E. projection to anchor a third scenario, our strippable coal reserves would be exhausted well before the year 2020. The range, then, of these scenarios puts the exhaustion of our strippable coal reserves at somewhere between 2020 and 2090.

We would like to present an appeal for a more regional mining plan which ensures a viable coal industry in the area for a more extended length of time than is represented by the more rapid scenarios. The West is notorious for having gone through boom after bust and bust after boom. These cycles owe their oscillation to a lack of recognition that the resource causing the boom -- be it oil or coal -- is in fact a finite resource. Coal is no exception, and we will be out of it soon if no restraint is shown by the leasing authorities. Very little control is left in the hands of the public after the coal has been leased.

Over half of the coal is already in the hands of the large oil and mining companies and their numerous subsidiaries. All the state owned coal in the Eastern Powder River Basin has been leased.

31

page 4

That coal under private ownership cannot and probably should not be restricted from development. Thus, the only handle left for the public is in the restraint of federal coal leasing. It is our opinion that enough federal coal is presently under lease to support a viable and in fact quite large mining operation in the region, and that only minimal federal leasing should take place until the present mining operations begin to taper off. A graph of expected production based upon the D.E.S. 'most probable' scenario is presented elsewhere in Powder River Basin Resource Council's written comments. Allowing for a substantial lag time between leasing and commencement of production, it is clear that a five to ten year curtailment of significant leasing would be advisable. As we feel the 'most probable' scenario is a conservative one, the graph will probably have a higher and later peak -- an argument for an even more extended curtailment of significant further leasing.

It is our opinion that this is the sort of analysis that the USGS and BLM should be coming up with -- an analysis which keeps in mind the historical element, the potential boom and bust cycles, the finitude of the resource being studied , and the stability as well as the viability of a coexistence between ranching and coal mining industries.

Respectfully submitted,

Robert S. Anderson, consultant
Powder River Basin Resource Council

<u>Letter 31 Response</u>

This comment letter presents a number of concerns which cannot be identified with particular parts of the ES. The following paragraphs respond to the letter as a whole.

This ES does not consider new coal leasing. The Department of the Interior is currently reviewing its coal leasing policies (a draft ES on the Federal Coal Management Program was issued in December 1978), and any new leasing would be the subject of future regional ESs. The concerns identified in this comment letter would be germane at the time new leasing is being considered.

Production projections beyond this century are largely academic. Projections for the region even to the year 2000 are subject to change, because they are dependent on competition from other coal (which may be influenced by legislation or new technology) and other energy sources. Furthermore, the depth to which stripping coal is feasible may change with economics and new technology.

Energy development boom and bust cycles in the west have historically been the result of changing market demand rather than presence or depletion of the resources. Changes in market demand can occur again.

Finally, the numbers cited in the comment vary in accuracy. (a) The reserve figures and percentages are within reason. (b) The acreage under federal lease in the region is 93,961.62 (personal communication, GS, Conservation Division 1979), and therefore the leased federal reserves would be approximately 9.4 billion tons (using the conversion factor of .1 million tons per leased acre). (c) The land under state coal lease amounts to 315,804.27 acres or 493 square miles (Glass 1976a). (d) The biggest error lies in assuming that all leased coal is strippable coal. (For example, only about 45% of the state coal leases lie in areas of strippable coal reserves.) The letter states that 46% of the strippable coal reserves are under federal lease. This number was derived by assuming an average coal thickness for all federally leased coal in the region, then comparing it to a research-derived reserve figure. It is doubtful that half the region's strippable reserves have been leased, let alone minable reserves.

The following are written comments received after the December 26th deadline. Some were received too late for complete responses to be prepared.

Advisory Council On Historic Preservation

32

1522 K Street NW.
Washington D.C.
20005

December 22, 1978

Team Leader
Coal ES Team
951 Union Blvd.
Casper, Wyoming 82601

Dear Sir:

This is to acknowledge receipt of the draft environmental statement for the Eastern Powder River Coal Region, Campbell and Converse Counties, Wyoming, on October 26, 1978. We regret that we will be unable to review and comment on this document in a timely manner pursuant to Section 102(2)(C) of the National Environmental Policy Act of 1969.

Nevertheless, the Bureau of Land Management is reminded that, if the proposed undertaking will effect properties included in or eligible for inclusion in the National Register of Historic Places, it is required by Section 106 of the National Historic Preservation Act of 1966 (16 U.S.C. 470f, as amended, 90 Stat. 1320) to afford the Council an opportunity to comment on the undertaking prior to the approval of the expenditure of any Federal funds or prior to the issuance of any license. The "Procedures for the Protection of Historic and Cultural Properties" (36 CFR Part 800.4) detail the steps an agency is to follow in requesting Council comment.

Generally, the Council considers environmental evaluations to be adequate when they contain evidence of compliance with Section 106 of the National Historic Preservation Act, as amended. The environmental documentation must demonstrate that either of the following conditions exists:

1. No properties included in or that may be eligible for inclusion in the National Register of Historic Places are located within the area of

32

Page 2
Team Leader
Eastern Powder River Coal Region
December 22, 1978

Historic Places are located within the area of environmental impact, and the undertaking will not affect any such property. In making this determination, the Council requires:

—evidence that the agency has consulted the latest edition of the National Register (Federal Register, February 7, 1978 and its monthly supplements);

—evidence of an effort to ensure the identification of properties eligible for inclusion in the National Register, including evidence of contact with the State Historic Preservation Officer, whose comments should be included in the final environmental statement.

2. Properties included in or that may be eligible for inclusion in the National Register of Historic Places are located within the area of environmental impact, and the undertaking will or will not affect any such property. In cases where there will be an effect, the final environmental statement should contain evidence of compliance with Section 106 of the National Historic Preservation Act through the Council's "Procedures for the Protection of Historic and Cultural Properties".

Should you have any questions, please call Brit Allan Storey at (303) 234-4946, an FTS number.

Sincerely,

Louis S. Wall
Assistant Director
Office of Review and Compliance, Denver

Letter 32 Responses

1. The ES has been revised to clearly state that procedures to provide compliance with Section 106 of the National Historic Preservation Act are currently in progress.

33

City of Gillette

December 22, 1978

Ms. Julia Elfving
Team Leader, Coal ES
951 Union Blvd.
Casper, Wyoming 82601

Re: Comments, Eastern Powder River Coal Draft Environmental Statement (including Buckskin Mine)

Dear Ms. Elfving,

This letter is in response to your request for comment on the Eastern Powder River Coal draft environmental statement. The City of Gillette has a direct interest in the disposition of matters relating to the development of coal in the region.

My comments will relate both to the statement in question as well as the process in general. Unless otherwise indicated, my remarks should be considered with respect to socioeconomics.

1 Joe Racine pointed out in his testimony at the public hearing that the population base estimates and projects are totally unrealistic. Page R4-45 projects a 1985 County population which is less than our December, 1977 estimate! I hope that Mr. Roy Allen's work with our planning office and with current literature will serve to correct this discrepancy.

2 Page R5-2 acknowledges that Gillette's air quality may already exceed the Wyoming 24-hour standard. What will be the effects of additional mines in the area and what measures, if any, can reverse this trend?

3 The reference to Gillette's budget deficit by 1985 on page R5-1 is vague. I suggest that your staff meet with the City Administrator to obtain a more complete picture of Gillette's capital improvement needs, etc.

P.O. BOX 3003 GILLETTE, WYOMING 82716

PHONE 686-2222

33

4 There is an apparent discrepancy in the mines projected full production employment. Page BU3-32 states that the permanent, 1990 employment would be 133. Presumably, this would be for a production level of 6 MTY, as presented in Shell's testimony at the hearing. However, the North Antelope and Pronghorn mines, each with similar projected production rates, anticipate 190 and 293 permanent employees respectively. If this apparently low projection is allowed to stand, the reasons for its being so much lower should be fully examined.

5 The potential for West Coast coal contracts and the resulting increase in train traffic through Gillette should be examined. Recent reports already paint a grim picture of the effects of unit trains on the town in the future.

6 An ever-increasing concern of the community is that leases were granted by BLM in the vicinity of the City of Gillette. This statement should include a complete and comprehensive analysis of the physical, social and economic consequences of surface mining in an urban environment. Also, the statement should evaluate alternatives to this environmentally-unacceptable condition such as lease trading. Considering the vast coal reserves in the area, the BLM made a very serious mistake in leasing so close to town. The statement should serve as a step toward correcting this error before it is too late.

Over the years of participation in this process I have made several observations regarding the NEPA process. I believe that these observations are particularly relevant in relation to a statement as far reaching as the Eastern Powder River.

7 One of the major shortcomings we notice in this statement, as well as in others, is the apparent intent of the overall process. The direction of the statement seems to be to simply meet the statutory requirements, rather than to perform the more substantive task of producing a working document which will somehow improve the manner in which coal is mined and the community provides for the needs of the incoming population.

In the area of socioeconomics, the identification and evaluation of mitigating measures is almost totally lacking. Page BU4-16 is an example. <u>No</u> socioeconomic mitigations are identified!

8 The identification and analysis of alternative mitigating measures is totally lacking in the area of socioeconomics. We recommend that the companies and the agencies drafting statements propose specific mitigations, including company activities, which will potentially help to alleviate growth pressures on the community. Such proposals should be evaluated and related to identified impacts in the draft environmental statement.

33

8 While such an approach has been neglected in this and in other statements, we believe that it is well within the scope and intent of NEPA. "Impacts" should encompass the positive as well as the negative. Also, companies should be given the opportunity to propose how willing they are to channel their resources into community projects. Such an approach would clearly identify individual companies' willingness to help implement solutions, an important factor in evaluating mine plans. Also, such a process would tend to stimulate a cooperative, rather than an adversary relationship between the mines and the community.

9 Impact mitigation in such an extreme case requires innovative measures and financing. This statement and others fall far short of this goal by failing to recognize that the Federal Government itself is a cause of much of the problem and is certainly a source of funds to meet the community's needs. Recognizing housing needs, why can't the statement call for HUD to adjust its subdivision approval standards to allow for more local control of local matters and encourage, rather than discourage housing production? Why can't the statement point to other federal agencies to fund capital improvements in <u>advance</u> of growth to relieve some of the burden on the community? All too often the Federally-drafted statements only concentrate on state, local and company solutions.

10 Another of the most common discrepancies in the evaluation of mine proposals is the tendency of both the companies and those preparing environmental statements to relate the site specific to the overall growth projections and conclude that a specific proposal is not significant. Campbell County <u>is</u> growing fast and experiencing the resultant intense level of development activity. This growth is due to coal mining. If each of the mining proposals is not addressed as an integral component of this overall significant "impact", then the process will fail to serve as a mitigating factor.

The Buckskin mine and each of the other mines in the region <u>are</u> significant contributors to growth and should be addressed as such.

11 We've noted that there is an almost total lack of consistency in base socioeconomic information among the many statements. The regional statement baseline should be corrected and used as a guide for other statements. Our planning office has recently engaged a consulting firm to update the Campbell County Economic Base Study. This will be available in February and would surely be a useful guide in establishing your data base.

33

12 Considering the level of mining currently taking place in the county, there is an opportunity to gather empirical data relative to the effects of mining in the county. The statement should call for an intense program of monitoring air quality, sound and seismic effects, etc. so that future evaluation of mines and their effects on nearby populations can be better understood. Statements can become less dependent on guesswork and company projections.

We recommend that the EIS hearing process be more extensive and less formal. Rather than rigid public hearings, a series of public meetings conducted by two or three knowledgeable persons would be less expensive and more productive. Formal hearings tend to intimidate the public and discourage response. A few people coming to Gillette for a few days would allow for informal presentations of the statements and more thorough discussion. Also, this would give those drafting the documents more of an opportunity to meet with local officials and the public to discuss and evaluate draft statements. The public input process should <u>activaly</u> solicit local input, rather than be satisfied with "one shot" formal hearings.

13 I request that information and analyses supplemental to the draft be developed and distributed for comment prior to inclusion in the final statement. This information and/or analysis would include anything developed subsequent to the draft which would fill the "gaps" in the statement outlined in this letter or in the comments of others. My staff and I would also like an opportunity to discuss your responses to these comments prior to the final draft.

We are not seeking any additional formal hearings or comment period. We only request that we be given an opportunity to comment on the content of the much-needed new material and to continue to actively participate in the EIS process.

Thank you for the opportunity to comment on this draft. We appreciate Mr. Allen's recent efforts to work with local officials as well as the extended deadline within which to prepare these comments. Please don't hesitate to contact me or Joe Racine in our planning office if you have any questions or if we can be of any assistance in the preparation of the final ES.

Sincerely,

Michael B. Enzi

Michael Enzi
Mayor

MZ/imb

Letter 33 Responses

1. The base and projected populations for Gillette and Campbell County have been revised throughout the text to reflect current local information.

2. Mines developed in the past in the Gillette area were not required to institute BACT (Best Available Control Technology) to control emissions of pollutants from the mines. The present mines and future mines will be required to use BACT to control pollutant emissions. This requirement should keep ambient air quality in the Gillette area in compliance with Wyoming and federal air quality standards.

3. Chapter 5 is intended to be a summary of the unavoidable adverse impacts. Detailed discussions of probable impacts are contained in Chapter 4.

4. The 1990 employment of 133 is for 4 million tons annual production. For reasons discussed in response 14-3, the revised mining and reclamation plan cannot be considered in preparation of the final ES.

5. Our analysis of the rail transportation of coal is based on the best available information as to markets, both firm and tentative. No west coast markets have yet been identified for Eastern Powder River Basin coal. Therefore, no increase in westbound coal train traffic through Gillette is expected.

6. Much of the analysis requested is already available in previous site-specific ESs (Kerr-McGee, East Gillette DES 77-13, April 1, 1977; Amax, Eagle Butte, FES 77-33, August 23, 1977; Carter, Rawhide, and Wyodak, FES 74-55, October 8, 1974), and is also included in the cumulative impacts discussed in this ES.

Existing leases in the vicinity of the city of Gillette are included in the high-level scenario in general terms, because there are no suitable specific mining and reclamation plans on file for impact analysis. When and if specific mining and reclamation plans are submitted for these leases, environmental assessments will be completed which could include alternatives for exchange of leases.

The leases in question were issued between 1959 and 1967, and Gillette has grown toward the leased areas since then.

7. The intent of this environmental statement is to analyze the impacts of coal development in the region, identify committed mitigating measures, and examine possible alternatives to the proposed action.

8. Mitigating measures to reduce socioeconomic impacts could be proposed by a company or suggested by local communities for consideration by companies or agencies, if appropriate. The opportunity exists for community and company officials to attempt to work out problems created by increased development.

9. The ES recognizes the financing and related problems faced by rapidly expanding communities in meeting public service and housing needs. These are complex problems and partial solutions are suggested. One way the federal government compensates the states which have mineral production from federal lands is to return 50% of the royalty to that state. In 1977, royalty payment to the federal government from Wyoming was $5.3 million, and in 1978 it is expected to be approximately $7 million, half of which will be returned to the State of Wyoming. Another way the federal government compensates local governments is through the payments in lieu of taxes. For fiscal years ending September 30, Wyoming received approximately $6.4 million in 1977 and $7.3 million in 1978.

10. We have pointed out in the site-specific analysis that although Buckskin would produce a small proportion of total regional coal mined, Buckskin-related population increases would significantly affect housing, city services, and recreation facilities; and further, that the impacts of any new mine on natural resources would contribute to regional impacts discussed in the regional ES.

11. Population data have been changed throughout the ES to reflect available local information. The updated Campbell County Economic Base Study mentioned in the comment was not completed before the final ES was printed. It will be useful for future studies.

12. Monitoring of the environment is required by implementing regulations of the Surface Mining Control and Reclamation Act. These regulations, as proposed now, require monitoring of ambient air quality, soil testing for evaluation of results of topsoil handling and reclamation procedures, monitoring of all water discharges from the mine area, and monitoring of groundwater.

In addition, on-the-ground inspections are required at a minimum of every 6 months. Additional inspections may also be made as considered necessary.

While there are no monitoring requirements for noise levels from mining activities, there are several proposed regulations for the use of explosives, which require preblasting surveys, public notice of blasting schedules, seismographic measurements, and records of blasting operations.

13. During the period of review between the draft ES and final ES, nothing has been identified which would necessitate republishing the draft or any portion of it. In parts of the draft ES where changes were found necessary, the corrections have been made. Data gaps identified either during impact analysis or through public review will be considered prior to any decision on the proposed action.

A meeting was held in early February 1979 with officials of the City of Gillette to discuss the concerns expressed in this comment letter.

34

OPTIONAL FORM NO. 10
JULY 1973 EDITION
GSA FPMR (41 CFR) 101-11.6
UNITED STATES GOVERNMENT

Memorandum

TO : Team Leader, Coal ES Team, 951 Union Blvd., Casper, Wyoming 82601
thru Dr. Clyde Jones, Director, National Fish and Wildlife Laboratory

DATE: December 15, 1978

8-20-12-78

FROM : Zoologist, Fort Collins Field Station, National Fish and Wildlife Laboratory
1300 Blue Spruce Drive, Fort Collins, CO 80524

SUBJECT: DES - The Eastern Powder River Basin of Wyoming
Reptiles and Amphibians

We wish to provide the following comments to the proposal:

R2-43 Habitat Types

Terrestrial

1 The snapping turtle in particular and the painted turtle are principally aquatic species, not "riparian" forms.

2 Bullfrogs may be introduced to the included two counties but there are few records from northern Wyoming. Its occurrence is marginal in the area.

3 Species of the terrestrial reptile fauna occur in the other habitat types, but none are mentioned.

R2-47 Reptiles and Amphibians

4 Forms that occur in the region but were not listed include:

Western spiny softshell (Trionyx spiniferus). An aquatic form.
Plains hognose snake (Heterdon nasicus nasicus)
Western Smooth green snake (Opheodrys vernalis blanchardi)
Common garter snake (Thamnophis sirtalis)
Wandering garter snake (T. elegans vagrans)
Red-belly snake (Storeria occipitomaculata)
"Rare" form in State of Wyoming.
In Crook and Weston Counties. Possibly elsewhere.
Eastern fence lizard (Sceloporus undulatus)
Many-lined Skink (Eumeces multivirgatus)
In Niobrara County, Wyoming.

The nongame wildlife at sites of the proposed project appear to be poorly known. Rigorous field census work in the region is largely nonexistent and apparently many forms of nongame wildlife were overlooked due to the paucity of published information.

If we can be of assistance to your field oriented studies, please feel free to contact us.

R. Bruce Bury

R. Bruce Bury

5010-110

Buy U.S. Savings Bonds Regularly on the Payroll Savings Plan

Letter 34 Responses

1. The two habitats are closely related due to the presence of water. The two turtle species undoubtedly use both habitats and were listed under the riparian heading for the sake of simplicity.

2. The bullfrog has been deleted from the species lists in Chapter 2 of the regional analysis.

3. The species lists by habitat type are intended to be representative rather than inclusive. A density table by habitat type for reptiles and amphibians has been added to the text in Chapter 2 of the regional analysis.

4. The first five species have been added to the list in Chapter 2 of the regional analysis. The last three, red-belly snake, eastern fence lizard, and many-lined skink, have not been added because their known occurrence is outside the area of analysis.

35

WYOMING
EXECUTIVE DEPARTMENT
CHEYENNE

ED HERSCHLER
GOVERNOR

December 26, 1978

Julie Elfving, Team Leader
Coal ES Team
Bureau of Land Management
951 Union Boulevard
Casper, Wyoming 82601

Re: Eastern Powder River
Coal Region of Wyoming

Dear Ms. Elfving:

We have completed our review of the above mentioned environmental statement. Comments received from the state agencies are enclosed.

Thank you for providing an opportunity to review the statement. Please keep us informed of the progress of this effort.

Our apologies for the delay of these comments.

Sincerely,

State Planning Coordinator's Office

CO:mee
Enclosures

35

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Wyoming Department of Agriculture

TELEPHONE: (307) 777-7321 CHEYENNE, WYOMING 82002

LARRY J. BOURRET, COMMISSIONER

M E M O R A N D U M

DATE: December 7, 1978

TO: State Planning Coordinator
Wyoming State Clearinghouse

FROM: Don Daiss
Assistant Commissioner and Liaison Officer
for E.I.S. Review

SUBJECT: Eastern Powder River Coal Region of Wyoming
State Identifier Number 78-128D

We have reviewed the draft and find the explanations of impacts are as well-written as, or better than, most environmental impact statements we have reviewed.

We have a concern relative to agriculture in that continually we find food and fiber production being squeezed as the need for natural resources goes on. Livestock grazing must be diverted to other grazing lands thereby creating a heavier impact on the remaining grazing lands while reclamation to restore the mining lands is a number of years in the future.

1 We also find consultation with numerous agencies--except the State Department of Agriculture--and would suggest that the 1978 Wyoming Agriculture Statistics is available for current data on agriculture in Wyoming.

We appreciate the opportunity to comment.

DDjh

Interagency

Letter 35 Responses

1. The 1978 Wyoming Agriculture Statistics were used in the final ES where applicable.

"AGRICULTURE—the backbone of Wyoming"

36

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

State Engineer's Office

BARRETT BUILDING CHEYENNE, WYOMING 82002

WYOMING WATER PLANNING PROGRAM

December 7, 1978

TO: Dick Hartman, State Planning Coordinator

FROM: Louis E. Allen, Water Resources Engineer

SUBJECT: Comments on Eastern Powder River Coal Draft Environmental Statement

1 1. There is recognition of the requirement for permits from the State Engineer for water appropriations, diversions, and impoundments in both the Regional Statement and the Buckhorn Mine Statement. The protection of existing water rights from interference without the owner's consent is only partially addressed and should probably be more explicit with regard to repair or replacement of the supply, or compensation for damages, under Wyoming water law.

2 2. Page R1-18, Table R1-7: The 10 A-F/megawatt requirement for water cooled power plants seems low. An allowance of 15 A-F/megawatt is generally accepted for planning purposes. Does use of the 10 A-F figure contemplate a combined cooling system, or some other consideration?

3 3. Page R2-41, second full paragraph: The statement relative to a 20 acre-foot limit on stock water reservoirs is not correct. The 20 acre-foot size is the maximum for a simplified permit procedure (if the embankment height does not exceed 12 feet). It is also the maximum size for the exemption of stock water reservoir accounting under the Yellowstone River Compact and the Belle Fourche River Compact which affect the statement area.

4 In this same paragraph with regard to the reduced yield per square mile (cfsm) leaving the region, this yield consistently becomes smaller as the size of the drainage area increases. The small reservoirs and spreader systems probably make only a small contribution to this inverse relationship between yield and drainage area.

5 4. Page R2-73, Figure R2-37: The map shows "Acme's Power Plant" in Sheridan County. This plant has been out of service for several years.

6 5. Page RC-5, Storage Coefficient: The definition is either poorly expressed or lacks part of the statement.

36

Dick Hartman
Page 2
December 7, 1978

7 6. Many statements in both the Regional and the Buckskin Project sections are too definite as to what would occur in the future under a given set of actions. We cannot be that certain, in most cases.

LEA:ew

cc: George L. Christopulos
William Long

Letter 36 Responses

1. The section on laws and regulations in Chapter 3 of the regional analysis has been expanded to include a section on water rights.

2. See response 15-1.

3. The text has been revised. See Chapter 2 of the regional analysis, Water Resources.

4. We believe the fact of decreasing unit yield in flow as drainage increases was conveyed by stating that 0.033 cfsm originates on the region but only 0.014 leaves the region.

5. Figure R2-37 has been corrected.

6. The missing words have been inserted. See Appendix C of the regional analysis.

7. Using the data available, we have used our best professional judgement to determine predicted impacts. We agree there are uncertainties in most predictions.

37

THE STATE OF WYOMING

Ed Herschler, Governor
Leno Menghini, Superintendent and Chief Engineer

Wyoming State Highway Department

P. O. BOX 1708 CHEYENNE, WYOMING 82001

M E M O R A N D U M

November 3, 1978

TO: State Planning Coordinator
Wyoming State Clearinghouse
2320 Capitol Avenue
Cheyenne, Wyoming 82002

FROM: William P. King, P.E., Environmental Services Engineer WPK

SUBJECT: Comments on Draft E.I.S. for Eastern Powder River Coal Region of Wyoming

State Identifier Number 78-128 0

We have reviewed the subject Draft E.I.S. and offer the following comments:

1 1. The E.I.S. notes that rail traffic is causing problems and impacts in communities and at highway crossings. We feel this is a much more severe problem than discussion in the E.I.S. indicates. We feel that it is time to seriously study mitigation measures. It is possible that train scheduling could provide some relief. At the other extreme the best solution might be relocation of the railroad or some of their supporting facilities. Coupled with this is a financing program for the mitigating measures.

2 2. As we interpret the proposal, the railroad to the Buckskin Mine will cross Highway 59 at grade. Since Highway 59 is a major State Highway it is the position of the Highway Department that this will have to be a grade separated crossing.

Letter 37 Responses

1. Given the scope of the ES, it would be beyond our present capabilities to fully explore all mitigating measures that are associated with rail traffic. What we have done is to simply point out the probable impacts of increased rail traffic and discuss changes that will alleviate these problems.

2. Wyoming State Highway 59 is currently being rerouted around the Carter Mining Company's Rawhide Mine, which is adjacent to the proposed Buckskin Mine. Upon completion of the highway relocation, State Highway 59 will pass over the Rawhide railroad spur on a bridge.

Shell Oil Company's railroad spur would pass under State Highway 59 at the same bridge.

The text has been revised to reflect this. See Chapter 3 of the site-specific analysis, Transportation Networks.

38

THE STATE OF WYOMING

EXECUTIVE DEPARTMENT

ED HERSCHLER
GOVERNOR

Office of Industrial Siting Administration

SUITE 500 BOYD BUILDING CHEYENNE, WYOMING 82002 TELEPHONE: 307-777-7369

Team Leader
Coal ES Team
951 Union Blvd.
Casper, WY 82601

Dear Sir:

We have reviewed the "Draft Environmental Statement on Proposed Development of Coal Resources in the Eastern Powder River Basin." Overall, the DES provides a valuable composite of descriptive environmental data for the Eastern Powder River Basin. However, we believe that the Statement has incorrectly identified the various levels of coal development. Specifically, the No Action alternative should include only those projects currently in production or under construction (please note that the Caballo Mine is already in production). The Most Probable Level should include those projects with valid leases in the active planning and permitting stage. Finally, the High Level should include valid leases without active projects, preference right lease applications, and potential
1 development on areas of interest. A listing of projects included in each alternative is given in the following table.

The projects listed under the No Action alternative are all producing mines at this time. The projects listed under Most Probable Level still require various State and Federal approvals. However, each project listed has either announced contracts, submitted permit applications, or indicated to a State or Federal agency that permit applications are being prepared. In contrast, the No Action alternative in the Statement includes several projects for which Federal approvals are currently pending and the Most Probable Alternative excludes from consideration many projects which will undoubtedly be in production before another regional environmental statement is prepared. Thus, the Regional Statement does not accurately evaluate the anticipated impacts associated with the Most Probable Level of regional coal development.

Specific comments on portions of the Regional Statement and the Buckskin statement are provided below.

Description of Regional Development Activity: (P R1-17)

2 It appears the figures in Table R1-6 for cumulative acreage disturbed due to population expansion underestimate considerably the regional situation.

38

Page 2

ALTERNATIVE LEVELS OF COAL PRODUCTION

No Action - Low Level

Wyodak - Wyodak Resources
Dave Johnston - PP & L
Belle Ayr - Amax
Cordero - Suned
Rawhide - Carter
Black Thunder - Arco
Jacobs Ranch - Kerr McGee
Kerr McGee #16 - Kerr McGee
Eagle Butte - Amax
Caballo - Carter

Most Probable Level

Coal Creek - Arco
Wildcat - Gulf
Norfolk - Gulf
Pronghorn - Mobil & Consol
Mobil Lease - Mobil
East Gillette - Kerr McGee
Antelope - PP & L
Buckskin - Shell
Rochelle - Peabody
North Antelope - Peabody
Wymo Fuels - American Electric
South Rawhide - Carter

High Level

Valid leases without active projects
Preference right lease applications
Potential development on Areas of Interest

Source: Table A-2 Staff Review Permit Application for the Atlantic Richfield Company Coal Creek Mine, Campbell County, Wyoming Docket No. WISA-78-1, July, 1978, The Office of Industrial Siting Administration.

38

Page 3

2 This is significant only in that these figures are used in later sections as a base for a number of calculations. The OES estimates that 2200 acres will be disrupted by a population increase of 22,000 by 1990 under the probable level of development and yet the City of Gillette alone saw the development of more than 2200 acres from 1965 to 1977 for an even smaller population increase. A major reduction in undeveloped land base is evident from the rural sprawl in the basin, particularly in Campbell County. Assuming a continuation of this situation, the OES estimate of 2200 acres for 22,000 people does not appear realistic. Rural sprawl should be considered in the ES to more realistically reflect probable land base development and subsequently provide more reliable estimates of impacts of regional development on other resources.

Fish and Wildlife: Terrestrial (p R2-43)

3 Regarding habitat affinities, beaver should be removed from the ponderosa pine habitat type and placed under riparian.

Fish and Wildlife: Mammals (p R2-44)

4 The document writers estimate pronghorn and deer density for the region as 20.8 and 3.0 per square mile respectively. However, these figures do not reflect density for the region since the data used to derive these estimates are from mine sites only, in a relatively small, restricted area of the entire basin. The estimates are totally invalid statistics even for the mine sites overall since they were improperly calculated (ie. densities per square mile for each of the mine sites were simply totaled and divided by the number of mine sites). The correct average density per square mile for the mine sites overall is approximately 15.7 for pronghorn and 2.1 for deer, assuming the mine site figures are not in error.

Economic Environment: Population (p R2-102)

5 The population estimates given Table R2-23 of 16,000 for Campbell County and 10,067 for the City of Gillette for 1978 are obviously in error. For example, the Wyoming Employment Security Commission estimates the labor force alone residing in Campbell County to be 13,507 as of September, 1978. The City of Gillette-Campbell County Department of Planning and Development estimated the 1977 County population to be 24,406 with 12,073 in the City of Gillette and an additional 5,424 in the Gillette area.

Environmental Impacts of Regional Development: General

6 The analysis of potential adverse environmental impacts associated with regional development is very limited. Throughout Chapter 4 is the frequent statement that no data is available to substantiate or quantify a potential adverse impact.

38

Page 4

6 The DES is remiss for not identifying or suggesting the means by which these data gaps will be filled. The ES should address the means by which these data gaps can be filled in order to properly discern the probable significance of environmental impacts of regional development.

Environmental Impacts of Regional Development: Surface Water (p R4-22)

7 Not unlike other environmental statements concerning coal mine development at sites with tributaries to the Belle Fourche River, this OES also ignores the issue of possible cumulative impacts of mining on sedimentation in the Belle Fourche and Keyhole Reservoir. Keyhole Reservoir is an important regional fisheries and multiple-use recreational resource that is of considerable concern to wildlife agencies respecting adverse impacts from regional development. Additionally, the DES does not sufficiently address the probable drawdown of the Belle Fourche as a consequence of destruction of near-surface aquifers and the pocketing of some surface drainages, or down-stream agricultural usage of the river. These are potential adverse impacts that could be significant and should be addressed in the ES. If data are not available for these potential impacts, are monitoring programs or basic research studies anticipated?

Environmental Impacts of Regional Development: Wildlife (p R4-26 to R4-28)

8 Direct losses of game species (ie. pronghorn and deer) should be recalculated since density estimates given in Chapter 2 were improperly derived. Also, estimates such as those given in Table R4-7 should be qualified with the statement that losses were calculated in proportion to the amount of habitat lost directly and does not account for indirect loss resulting from barriers to migratory movements to or from critical winter range, the additional acreage in a buffer zone around access roads, rail spurs, or other rural developments that may be uninhabitable for some wildlife species, and the loss associated with increased human encroachment and disturbance in otherwise undisturbed habitat. Though obviously not calculable, the magnitude of loss could be much greater than that predicted.

Environmental Impacts of Regional Development: Socioeconomic Conditions (p R4-43 to R4-48)

9 The Socioeconomic impacts associated with regional coal development are consistently underestimated due to the extremely low population estimate for 1978 developed in Chapter 2. This entire section should be reevaluated based on more reasonable population estimates.

PROPOSED BUCKSKIN PROJECT

Description of the Project: Watercourse Diversions (p BU1-15)

10 We do not believe that the 20 year flood is adequate as the design flood for the diversion system due to the high probability of being exceeded during the life of the mine and the probable impacts associated with the failure of the diversion system.

38

Page 5

Description of the Environment: Groundwater (p BU2-8 to BU 2-12)

11 The DES states that there are 52 wells within three miles of the lease, many of which were drilled for stock or domestic supplies. The document does not indicate whether any of these wells are drilled in aquifers that will be disrupted or indirectly impaired by the Buckskin mining project. There is no indication of mitigating impaired wells or delimiting the area of groundwater influence by the Buckskin project from that of adjacent mines. The ES should clarify the probable impact on existing wells, if any.

Description of the Environment: Surface Water (p BU2-12)

12 There are apparently 5 reservoirs presently on the lease area but no indication is given as to their replacement for livestock and wildlife watering purposes. Please clarify.

Impacts of the Proposal: Game (BU3-27)

13 The DES suggests that the rail spur, if fenced, and in combination with the mine itself and the access road, would form a barrier to north-south movement by pronghorn between Highways 14/16 and 59. If properly designed, the rail spur fence should not prohibit pronghorn movement. The project should follow the fence structure guidelines proposed by the Wyoming Game and Fish Department to avoid this potential impact.

Thank you for the opportunity to comment on the draft statement. We hope our comments will be useful to you in the preparation of a final statement.

Sincerely,

Blaine E. Dinger, Director

BED/sr

Letter 38 Responses

1. Please see transcript response #4 and response 28-1. We have amended our tables in Chapters I and 8 of the regional analysis to show Caballo's 1978 production.

2. Acreage allowance for population increase over 1978 base has been increased.

3. A change in the text has been made. See Chapter 2 of the regional analysis, Fish and Wildlife.

4. Figures for big game densities have been obtained from the Wyoming Game and Fish Department for the major big game herd units in the region. The figures for all herd units were averaged and used in assessing impacts. The text has been changed to reflect the new figures. See Chapter 2 of the regional analysis, Fish and Wildlife.

5. Your observation is correct, and these estimates have been changed throughout the text.

6. Data gaps are deficiencies which are identified and considered in evaluating environmental impacts. If a data gap is considered significant, a decision to defer action can be made.

7. Total sedimentation from the region is estimated in Table R4-4. An estimate of possible increased sedimentation might be obtained through the use of the 7 acre-feet per square mile per year value (see Chapter 4 of the regional analysis) in conjunction with an estimate of the unreclaimed mine areas left exposed each year within the Belle Fourche River drainage. The summation of these annual computations should then give a very rough estimate of the increase in sediment accumulated in Keyhole Reservoir as the result of mining. We do not have available estimates of annual unreclaimed acreage by specific drainage.

Probably all but a very small percentage of the water supply into Keyhole Reservoir is the result of direct runoff from rain or snow and not the result of groundwater seepage. Current estimates indicate no significant reduction in river flow; if there is a significant impact, it will probably be in flow quality. Laws require monitoring programs, and research of mined areas is anticipated.

8. Direct losses of game have been recalculated using new figures from Chapter 2. A statement that wildlife losses were calculated in proportion to the amount of habitat loss has been incorporated in Chapter 4 of the regional analysis.

9. The text has been revised.

10. State regulations prescribe a much larger flood design (refer to Chapter 4, Mitigating Measures, of the site-specific analysis).

11. The section on laws and regulations in Chapter 3 of the regional analysis has been amended to describe provisions protecting water rights.

Changes in water levels in bedrock aquifers would be virtually the same, with or without the Buckskin Mine. The text of Chapter 2, Future Environment, of the regional analysis, has been so revised.

Quantitative data on the impacts to existing wells is not available; a qualitative description is given in Chapter 4 of the regional analysis.

12. The Wyoming Department of Environmental Quality will require restoration of reservoirs. The impact statement indicates that restoration of reservoirs is a committed or enforceable mitigation measure. See Chapter 4 of the site-specific analysis.

13. The construction of fences which permit movement of pronghorn is a committed mitigating measure. See Chapter 4 of the site-specific analysis.

39 DEC 7 1978

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Wyoming Recreation Commission

604 EAST 25TH STREET CHEYENNE, WYOMING 82002

JAN L. WILSON
Director
777-7696

December 6, 1978

Mr. Richard Hartman
State Planning Coordinator
Wyoming State Clearinghouse
2320 Capitol Avenue
Cheyenne, Wyoming 82002

Dear Mr. Hartman:

1 The Wyoming Recreation Commission would like to see the Bureau of Land Management in its "Draft Environmental Impact Statement: Eastern Powder River Coal Region of Wyoming--78-128D", address the impacts on recreational facilities in Converse and Campbell Counties as well as the lands under consideration for mining. Recognizing local concern for the scenic, historic, and recreational lands and facilities in the State and realizing the responsibility of this generation to protect Wyoming's quality of life, we feel provision should be made for meeting recreational needs in newly formed high density population centers where present facilities often prove inadequate.

Sincerely,

for Jan L. Wilson
Director

Robert Stevenson

by Robert B. Stevenson
Recreational Specialist

JLW:RBS:klm

39 DEC 7 1978
c-17

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Wyoming Recreation Commission

604 EAST 25TH STREET CHEYENNE, WYOMING 82002

JAN L. WILSON
Director
777-7696

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December 6, 1978

Mr. Richard Hartman
State Planning Coordinator
Wyoming State Clearinghouse
2320 Capitol Avenue
Cheyenne, Wyoming 82002

Dear Mr. Hartman:

Our office has received and reviewed your memorandum of October 30, 1978, and attached "Draft Environmental Impact Statement: Eastern Powder River Coal Region of Wyoming--78-128D".

The Historical Section of the Wyoming Recreation Commission appreciates the opportunity to review this two-part statement, including a regional impact analysis of existing and anticipated coal development and a site specific study of the Buckskin Mining and Reclamation plan. In truth, we are very pleased to find that this study has tapped professional archeological and historical sources in drafting a solid regional analysis. We specifically compliment the respective studies of Bob Murray and Alan Alpert, Cultural Resource Inventory of the Caspar District, Wyoming, and Description of Historic Events Relating to Potential Coal Lease Areas. Both are articulate works based upon substantial historical research.

2 The Wyoming State Historic Preservation Officer (SHPO), however, has identified numerous additional sites eligible for the National Register of Historic Places within the Eastern Powder River Region, which are not included within the draft. For your information, we are forwarding to your office an updated copy of the Wyoming Inventory of Historic Sites for Converse and Campbell Counties. Moreover, please note the Bureau of Land Management listing of the LX Bar Ranch is absent from the official inventory. Bob Murray notes the site's historic significance on page 283 of his cultural inventory.

Again the first portion of this Draft EIS is an overall management tool. This office will conduct more comprehensive reviews as subsequent EIS are filed for specific developments.

39

Mr. Richard Hartman
State Planning Coordinator
Cheyenne, Wyoming 82002

Page Two

December 6, 1978

3 Regarding one such specific development, the proposed Buckskin Mine, I find no historic sites either enrolled in or eligible for the National Register. However, a possibility exists that "recorded history" began earlier than 1883 (page BU2-16). William P. Hunt's journal reveals that the Astorian Expedition of 1810-1811 may have traversed the region on their way to the mouth of the Columbia. We would like to remind those who are involved in construction work that should they discover any evidence of this route, they must halt work and contact the SHPO immediately.

Since the entire Buckskin permit area has been surveyed by the Wyoming State Archaeologist and has been found to contain no site of National Register caliber, the SHPO can recommend clearance. We again would like to reiterate that should sites of unknown cultural values be uncovered during overburden removal, the State Historical Preservation Officer be notified as required in Section 106 of the Historical Preservation Act of 1966.

Sincerely,

Jan L Wilson

Jan L. Wilson, Director &
State Historic Preservation Officer

By:

Greg Kendrick, Special Assistant
Historical Section

JLW:GDK:klm
Encls.

39

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Wyoming Recreation Commission

604 EAST 26TH STREET CHEYENNE, WYOMING 82002

JAN L. WILSON
Director
777-7695

December 21, 1978

Richard Hartman
State Planning Coordinator
2320 Capitol Avenue
Cheyenne, Wyoming 82002

Dear Mr. Hartman:

4 Reference is to my letter of December 6, 1978, commenting upon the "Draft Environmental Impact Statement: Eastern Powder River Coal Region of Wyoming--78-128D". The Wyoming State Archeologist has completed testing on sites 48CA 89 and 48CA 130, located within the Buckskin mining permit area. Both sites are now considered eligible for enrollment in the National Register of Historic Places. Therefore, the State Historic Preservation Officer cannot recommend clearance of the mining operation until the Bureau of Land Management, in consultation with the SHPO have applied the criteria of effect as outlined in the National Historic Preservation Act of 1966, as amended "Protection and Enhancement of the Cultural Environment (36CFR800.3a)".

Sincerely,

Jan L. Wilson, Director and
State Historic Preservation Officer

By:

Greg Kendrick, Special Assistant
Historical Section

JLW:GDK:klm

40

MEMORANDUM

TO: Robert E. Sundin, Director

FROM: Thomas J. Mueller, Water Quality Sheridan District Supervisor

SUBJECT: Draft Environmental Statement "Proposed Development of Coal Resources in the Eastern Powder River Basin of Wyoming".

The following comments are offered on the Draft Environmental Statement.

1 1. On page R3-5, under the Water Quality heading, the Water Quality Standards for Wyoming are mentioned and described. Those standards have been superceded by the "Quality Standards for Wyoming Surface Waters", which became effective June 6, 1978.

2 2. On page R2-119 it is stated that "communities face difficulties in obtaining sufficient funds for . . . modern sewage treatment facilities". The availability of 75% federal funding through the EPA Municipal Grants Program should be pointed out, as should the existence of Coal Tax Grant monies, available from the State Farm Loan Board.

3 3. There are currently several small, marginally adequate, troublesome sewage treatment facilities serving housing subdivisions in the unincorporated areas around Gillette. No mention of these facilities, their impact, or likely proliferation is made anywhere in the document. This is a significant oversight.

4 4. A description of the Gillette water supply is provided on page BU2-29. The description is slightly inaccurate in that Electrodialysis treatment is no longer used.

5 5. On pages R4-50 and R8-24, statements are made indicating that the City of Sheridan's sewage treatment facility should remain adequate through 1990. The Water Quality Division does <u>not</u> presently consider the treatment facility adequate. The problems are primarily treatment efficiency and the very high quality of the receiving stream (Goose Creek). The City presently has a Step 1 grant from EPA for planning of facility improvements.

6 6. The "Most Probable Level" of Coal Production cited in the document is unrealistically low. The various Divisions of this Department are aware of as many as eight potential coal mining operations which are not identified in the regional analysis. Some of these operations have existing Federal coal leases, and some are entirely on State or private coal. While some, many, or all of these projects may be delayed or cancelled, it is unrealistic to assume that only those projects which presently have or are preparing Environmental Statements will be in operation by 1990.

<u>Letter 39 Responses</u>

1. The impact sections of both the regional and site-specific analyses discuss the effects of increased population on recreation facilities.

2. Chapters 2 and 4 of the regional analysis have been revised to account for the additional sites eligible for the National Register.

3. The year 1883 is established by documentation. While it is true that the Astorian Expedition of 1810-1811 may have traversed this region, we have no definite proof of travel across the Buckskin Mine site.

Chapter 2 of the regional analysis, Cultural Resources, describes the travels of the Astorians.

4. Documentation for compliance with the National Historic Preservation Act is currently in progress.

<u>Letter 40 Responses</u>

1. The text has been corrected. See Chapter 3 of the regional analysis.

2. The section on local finances, Chapter 2 of the regional analysis, discusses various sources of revenue available to communities.

3. This problem was discussed briefly in Chapter 2 of the site-specific analysis, Socioeconomic Conditions, Waste Disposal. The text there and in Chapter 2 of the regional analysis has been changed to reflect your concern.

4. This sentence has been corrected.

5. The text has been changed to reflect your concern. See Chapters 4 and 8 of the regional analysis, Economic Impacts, Local Services.

6. Please see transcript response #4.

41 DEC 1 ? 1978

MEMORANDUM

TO: Robert Sundin, Director

THROUGH: Randolph Wood, Administrator

FROM: Richard L. Schrader, District Engineer

SUBJECT: Draft Environmental Statement on the Proposed Development of Coal Resources in the Eastern Powder River Basin prepared by the Department of the Interior.

DATE: November 14, 1978

The following comments pertain to the above subject environmental statement:

1 1) Annual dispersion modeling predictions for TSP in the mid-1980's compare closely with predictions made by the Division during permit reviews if receptors within the lease boundary are not evaluated. Emissions were estimated for all mining operations as well as fugitive dust emissions for access road traffic.

2 2) Applications for proposed mines which are presently being reviewed by the Division and were not included in the regional dispersion modeling are as follows:

	Date Received
Rojo Caballos Mine	6/28/78
Fort Union Mine	10/30/78
North Antelope	11/09/78

3) An air quality permit was issued on October 16, 1978 for construction of the WYMO Mine. Public notice proposing approval of the South Rawhide Mine air quality application was published on October 17, 1978. Neither of these mines were included in the air quality assessment.

Letter 41 Responses

1. No response necessary. This comment supports the technique used in the ES.
2. Please see transcript response #4.

42

Team Leader
12/26/78

Page Two

3 3) The impact of transmission lines is discussed in the Statement- but only insofar as 230 KV line is concerned. None of the mines to date can use 230 KV. Thus a whole system of 69 KV feeder lines is building rapidly in the area. The Statement should address the commitment to not just 230 KV lines - but 69 KV as well. This information should be available from Tri-County Electric Association in Sundance, Wyoming, and also Pacific Power & Light in Douglas.

4 4) The treatment of air quality impact is alarmingly poor in the Statement. While Interior finds total emissions from mines in 1990 to be 41,513, PEDCO figures indicate 296,000 tons. (Interpretation of PEDCO Environmental, Inc. Study, "Survey of Fugitive Dust from Coal Mines" by Gerald Dodson, Office of the Solicitor, Department of Interior, Washington, D.C.) Using PEDCO and Dodson, we find the Statement has underestimated the emissions in the region by at least 700 percent.

5 5) The Statement indicated that both annual and 24 hour air quality standards will be violated in Gillette in 1990. Why are no alternatives discussed to mitigate these violations of Federal and State law?

6 6) In many places where air quality is discussed, Interior cites new PSD standards which seemingly exempt fugitive dust. The first critical point is that these regulations are interim, and are undergoing litigation and in-house re-evaluation. More importantly, dust will not somehow evaporate as a serious threat to health and property just because of a cleverly written legal exemption. Dust continues to fill the air in Campbell and Converse Counties, to cover grasses, decrease visibility and exacerbate respiratory problems among the residents. Interior has an obligation and a responsibility to "study, develop, and describe appropriate alternatives and to recommend courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources," (Sec. 102 (2) D) NEPA). Dust is such a "conflict" in this region and mitigation measures must be provided.

7 7) Enclosed please find a "High Country News" article on the "small, temporary fugitive dust sources" (R4-3) due to construction. Hap Stuart has experienced TSP levels over 800 ug/m^3 for large areas of land. Many such "insignificant" impacts are adding up. The regional Statement has done an abysmal job of detailing the regional impacts of the growing number of construction sites. It should be noted that construction activities are not necessarily "temporary." The mainline Railroad from Gillette to Douglas is taking over 5 years to build, and spurs can take a year or more.

8 8) Why were vehicle emissions not included in the dispersion models? (R4-3). Again, this Statement is supposed to be a regional accounting of regional impacts. No showing has been made that vehicle emissions are not a significant regional impact.

9 9) Table R3-1 should be thrown out. The regional Statement considers impacts within the State of Wyoming - and the State of Wyoming does not recognize Federal Primary Standards. All air quality standards in Wyoming are either the same or stronger than Federal Secondary.

42

Powder River Basin Resource Council
Sheridan, Wyo. 82801
48 N. Main
~~150 W. Brundage~~
(307)672-5809

Team Leader
Bureau of Land Management
951 Union Blvd.
Casper, Wyo. 82601

12/26/78

Dear Team Leader:

The Powder River Basin Resource Council would like to submit the following comments on the Draft Environmental Statement - Eastern Powder River Coal, made available to the public on October 25, 1978.

The comments are generally divided into two parts. The first section deals with the regional statement. The second addresses the specific Buckskin mine statement.

REGIONAL COMMENTS

1 1) Developments outside of the two-county region should be examined as to their potential to affect the study area. Specifically, coal and uranium development in Johnson, Niobrara, Weston and Crook Counties promises to impact communities in Campbell and Converse Counties.

2 2) Enclosed with these comments please find a listing of all mines presently in operation, under construction, or in the permit process in Campbell County. We noted in our oral comments that Interior had overlooked several mines in their analysis. The facilities not mentioned in the Statement are as follows:

A) Peabody Coal Company/Panhandle Eastern Pipeline Company - North Antelope Mine.
B) Pacific Power & Light - Antelope Mine.
C) WYMO Fuels, Inc.
D) Delzar - Ft. Union Mine.
E) Mobil Oil - Rojo Caballos.
F) Carter Oil/Exxon - South Rawhide.

The exclusion of these facilities has led to an underestimation of coal production by some 40 million tons of coal per year, possibly by 1985. Further, production from such mines as Belle Ayr, North Rawhide, Black Thunder, and Coal Creek is projected to increase substantially - well over the rates reported in the Regional Statement. This will further jeopardize the accuracy of the document.

For purposes of assessing impacts, Interior should not just look to which mines are in the impact statement process. To discover all planned development in the Basin it is necessary to consult with the Wyoming Department of Environmental Quality, Industrial Siting Council, and information gathering groups such as the Powder River Basin Resource Council.

42

Team Leader
12/26/78

Page Three

10 10) Water is another poorly treated subject in this impact statement. Water use is estimated by Interior to be 20 acre-feet per million tons of coal produced. The serious omission here is the average of 217 acre-feet inherent in every million tons of coal which is shipped out of the country. This represents an underestimation of water consumption impact by over a factor of ten. In 1990, water consumed in the region will be close to 110,000 acre-feet - not 70,450 acre-feet (R1-19) as predicted by Interior.

It is imperative that Interior tackle this problem in the true spirit of NEPA Sec. 102 (2)(D). What long term effects will coal mining really have on the water resources of the region? What can be done to mitigate the impact of heavy water consumption to an already very dry area?

11 11) The only apparent index used to determine the amount of destruction of wildlife is the elimination of habitat. But the very large kill factors (possibly of more significance than the loss of habitat) are poaching, car deaths, and domestic "pets." Every attempt should be made by Interior to determine what these losses are, even if it requires rough calculation.

12 12) It would be helpful to discover what the new large electrical loads in the area have done to energy costs. The electrical demand for each additional million tons of coal seems to be close to 1000 KW. (Data developed from 1978 electric usage of area mines, Tri-County Electric Association). Consumption of electricity averages 2.32 KWH per ton produced. (Average from Belle Ayr, Cordero, Jacobs Ranch, North Rawhide, and Black Thunder).

13 13) Gillette, apparently, will require an increase in the capacity of their sewage treatment facilities by 2.6 mgd. The City also needs 7.5 mgd additional capacity in the water treatment system. Further, a seven million dollar "shortfall" is expected by 1990. First, how does the Statement define "shortfall?" What level of services are assumed for 1990? Finally, how does the Statement suggest to alleviate those problems?

14 14) Coal dust loss from unit trains has been ignored. Estimates from the DES for Pronghorn mine, August 1978, show 3 tons of coal are lost per train. (Pg. BIV-4). If 15,705 loaded trains are to leave the Basin every year, the amount of coal dust emitted will be approximately 47,000 tons of coal dust. This is not to say that all will be lost within the confines of the region - but there is a good argument to say a large proportion escapes early in the trip.

Mitigating efforts such as oiling the railroad cars, or covering them should be seriously studied by Interior.

15 15) The "Regional Activity" map needs to be updated and expanded. The Rochelle holding has been partially re-assigned to include the Peabody North Antelope Mine. The existing and proposed rail spurs as shown are incomplete. 69 KV feeders should be drawn in. All AVF's should be drawn in (some 10.35 square miles, R2-29)

All state mineral leases should be included on this map. The development of these leases is very critical to the assessment of regional impacts.

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16) The map on R4-40 should be expanded to include the destination of all coal trains and the power plants which are being served.

16 Transportation maps should also include all of the proposed slurry line routes from beginning to end. Interior should further determine the potential mines to transport via slurry, and all of the plants, mostly in the South, which propose to use slurry. Mr. Frank Odasz of ETSI in Casper should be consulted.

17 17) The final statement should include a summary of regional activity and the coincident impacts. Environmental statements rely in large part on the public for their effectiveness. If the general public does not have the time or patience to wade through such lengthy documents, Interior should provide a summary more readable to the people who live in the region.

18 18) It should be noted that a new rail line is envisioned by the C&NW railroad to run from Shawnee, Wyoming to Gering, Nebraska. The line is expected to carry coal from the Powder River Basin.

19 19) Consult the enclosed report, "Impact of Coal Transportation on Gillette, Wyoming, and Communities South and East" issued September, 1978.

20) Refer to "Federal Coal Leasing in 1985 and 1990, Regional Coal Production Forecast." This DOE publication projects coal production in the Powder River Basin (S.E. Montana, and N.E. Wyoming by their definition) to fall between the three possibilities below;

20 PROJECTION, 1990 PRODUCTION:	Low:	173.7 Million tons
	Med:	396.1 " "
	High:	602.9 " "

If these figures are to be used to determine the level of leasing of federal coal in the Basin, then the Statement should consider what effects the Medium and High rates will have on the region.

21) Finally, the discussion of mitigating alternatives, which begins and ends on page R8-1, is virtually useless. While the Statement points out "alternative sites for surface facilities, mining technology and methods, coal transport methods and rates of production on individual operations were considered where appropriate," it goes on to say, "But no such modifications have been proposed or identified which would significantly reduce the adverse impacts of coal production from the region."

21 Basically, the Statement has failed in one of its most principal obligations as set forth in Sec. 1500.8 of the Environmental Impact Statement Guidlines. Sec. 1500.8 (a)(4) Content of Environmental Statements reads, "The following points are to be covered: ...Alternatives to the proposed action, including, where relevant, those not within the existing authority of the responsible agency. A rigorous exploration and objective evaluation of the environmental impacts of all reasonable alternative actions, particularly those that might enhance environmental quality or avoid some or all of the adverse

42

environmental effects, is essential."

The two supposed alternates presented in the Statement were listed as the "Low-Level Scenario," and the "High-Level Scenario." However, the Low-Level Scenario represents an insignificant drop (2%) in total development from the Probable Level of activity. The High-Level does not discuss any alternatives which could possibly "enhance environmental quality or avoid some or all of the adverse environmental effects" since it follows a 90 percent increase in development and industrialization of the region.

The section on alternatives needs to be given serious attention, creative thought, and lots of time. Ideas for mitigating alternatives, or areas in need of further thought are listed below:

21
A) Staggered mining approval after 1990.
B) Mass transportation of workers.
C) Alternative methods of reclamation to achieve legal standards.
D) Discussion on how to best rebuild mined aquifers.
E) Suggestions to avoid massive wildlife destruction.
F) Methods to reduce the large amounts of dust generated by industrial activity.
G) Possibilities to relieve social tensions and psychological depression familiar to energy boom towns.
H) Thoughts on ways to avoid large spending shortfalls in municipalities without decreasing the level of services.
I) Alternative siting of major utilities, roads and subdivisions.
J) More effective ways to upgrade information and utility of regional impact statements.

BUCKSKIN COMMENTS

These comments are specifically directed to the proposed Buckskin mine to be operated by Shell Oil.

22 1) 1.5 miles of alluvial valley floor have been found within the permit boundary of the the Buckskin mine. Has Shell shown that the mining and reclamation operations preserve "throughout the mining and reclamation process the essential hydrologic functions of alluvial valley floors"? Sec. 515 (e)(10)(F), SMCRA.

23 2) The impact of 1302 acre-feet of water inherent in the coal being extracted from the land at 6 million tons per year needs to be evaluated.

24 3) Figure R2-3 shows a major portion of the wind passing over Buckskin has lareedy passed over the mine to the south. This further challenges the already abnormally low estimation of air pollution surrounding the mine.

25 4) The final statement should detail the full costs of the facility to facilitate evaluation of tax generation potential.

42

26 5) Alternatives to increase the viability of reclamation are badly needed. The DES states that reclamation will only stabilize at 87 percent of premining levels of productivity. It was also shown that with planned reclamation procedures, large amounts of soil loss will occur due to large precipitation events.

27 6) The discussion on BU3-24 concerning settlement of post-mined land is good. More research, however, is required in this area to better determine what will actually happen to this land after mining and reclamation. There is a large question as to the ability of the returned overburden to hold water in any usable fashion. The question of settling of the land is critical, since if the area is to be farmed at a latter time ponds and depressions would create an unacceptable environment.

28 7) According to PEDCO, an average fugitive dust emission per million tons of coal in the West is 600 tons. Shell has air quality permits to 6 million tons of coal per year. This places the rate somewhere around 3600 tons of dust per year, rather than the projected 1000. The alternative to build a conveyor appears to be a useful mitigating measure and should be seriously considered by Shell. Other alternatives should be detailed to alleviate dust emissions from the mine.

29 8) As in the regional statement, the discussion of alternatives to the mine as proposed is not at all thorough. It has come time for Interior to assume an active responsibility in finding mitigating alternatives to a proposed action which would reduce its impact.

* * *

Thank you for the opportunity to comment on the Draft Environmental Statement - Eastern Powder River Coal, and the DES for the Buckskin mine. Please accept the referenced materials which are enclosed, and also a graph entitled "Production Curve for Eastern Powder River Coal Mines" which is to accompany testimony from R. Anderson.

Respectfully,

REED ZARS

Reed Zars, for the
Powder River Basin Resource Council
48 N. Main
Sheridan, Wyoming 82801

Letter 42 Responses

2. See transcript response #4.

3. See transcript response #5.

4. See transcript response #7.

5. See transcript response #8.

7. The effects of construction on air quality and vegetation are discussed in Chapter 4 of the regional analysis, Soils, Vegetation, and Air Quality. The fact that construction projects (such as the railroad and transmission lines) are short term for each given segment means that they could not be included in the air quality modeling and isopleths, not that they were considered unimportant.

8. See transcript response #10.

9. Table R3-1 compares federal and state air quality standards. Both sets of standards are compared with projected air quality, except where federal standards have no Wyoming counterparts.

11. See transcript response #12.

12. See transcript response #15.

15. Railroad spur and lease holding information was derived from company-submitted mining and reclamation plans and/or lease files. It reflects the best information available to us at the time the ES was written. Feeder power lines are usually constructed within rail spur rights-of-way and hence are not shown separately. Alluvial valley floors would be difficult to map at the scale of Map 1; however, those identified by Hardaway and others (1977) lie within the following lease areas: Belle Ayr, Black Thunder, Buckskin, Caballo, Coal Creek, Cordero, Dave Johnston, Eagle Butte, East Gillette, Jacobs Ranch, Rawhide, Rochelle, and Wyodak. See transcript response #16 in reference to state leases.

18. Please refer to response 29-5.

23. See transcript response #14. The 6-million-ton production figure is derived from Shell's revised mining and reclamation plan. See response 14-3.

26. The 87% figure is no longer valid. See response 14-49.

Concerning soil losses due to large precipitation events, such losses would be unavoidable under the present mining and reclamation plan if extraordinery rains occur during the reclamattoe process.

43

Casper, Wyo
Jan. 11, 1979

Julie Elving
Team Leader
Coal ES Team
Bureau of Land Management
951 Union Blvd.
Casper, Wyo. 82601

Dear Mrs. Elving:

I have studied the Draft Environmental Statement for coal development in the Eastern Powder River Basin. I am a student who is interested in the development of energy resources and what it does to our environment.

I think the project should move forward immediately to prevent an energy crisis in the future. This project will cause certain environmental changes but the benefits will be greater than any changes for the worse.

Respectfully yours,
Mark Onstott
1601 Nottingham
Casper, Wyoming 82601

Letter 43

No response required.

44

THE STATE OF WYOMING

ED HERSCHLER
GOVERNOR

Game and Fish Department

CHEYENNE, WYOMING 82002

EARL M. THOMAS
DIRECTOR

DES #142, Eastern Powder River Coal

January 9, 1979

Mr. Daniel P. Baker, State Director
Bureau of Land Management
2515 Warren Avenue
Cheyenne, Wyoming 82001

Dear Mr. Baker:

We have reviewed the Draft Environmental Statement for proposed development of coal resources in the Eastern Powder River Basin of Wyoming, and offer the following comments and recommendations in the interest of the wildlife resource.

1 This DES covers an extended region to the north bank of the North Platte River but does not include any potential effects on the river. The North Platte River is an important fisheries resource and riparian habitat which would be impacted by coal mining in the region even if none of it occurs within its drainage. Impacts ranging from increased demands for water-based recreation to increased construction and pollution would result.

2 On March 9, 1977, the Game and Fish Department transmitted a letter to the BLM concerning proposed planning decisions for Campbell and northern Converse counties. In this letter a ten mile buffer zone was recommended between the North Platte River proper and all surface occupancy. We reiterate and assert that this is a realistic and valid recommendation as we have monitored leaching from a surface mining operation within a two-to-three mile distance of Seminoe Reservoir. Leaching can stem from a multitude of controllable practices (sump pond wash-outs, mining operations, etc.), as well as from natural largely uncontrollable phenomenon such as underground aquifers, etc.

Any concessions to the recommended buffer zone width could pose additional, serious threats to the aquatic resource of the North Platte River and its multiple reservoir complement.

3 This Department's recent report (Fleischer 1978) to BLM assessed the fisheries and aquatic habitat in the Eastern Powder River Region. The following recommendations from that report should be addressed in the ES.

44

Mr. Daniel P. Baker Page 2 January 9, 1979

3
1. Rawhide Creek, on the Buckskin Site, be classified as Class III stream instead of the present IV water quality classification.
2. Reclamation-built reservoirs be assessed in view of their fishery potentials and their impacts.
3. Reclamation-built reservoirs with acceptable water quality be developed as early as possible in the mining process into sport fisheries.
4. Aquifer monitoring to assess ground water impacts by coal strip mining.
*5. Avoid aquifer disturbance and implement methods to reclaim aquifers to a pre-mining function.
*6. Instream flows match the historic flows of the region.
*7. Regional water quality be maintained.
8. Mining reclamation measures be in terms of wildlife.
9. Life history and current population studies be performed on the state listed rare species; shovelnose sturgeon, sturgeon chub, goldeye, and silvery minnow, etc.
*10. Stream channels be avoided by mining operations.

The following comments are arranged by chapter, section, and pagination of the DES:

<u>PART I - REGIONAL ANALYSIS (Chapters R1 thru R8)</u>

4 The combination of the regional analysis of coal development in the area with the site-specific DES for the proposed Buckskin Mine is confusing to the reader. The Buckskin Mine DES is seriously deficient in data and probably should not have been released, even at the risk of not being covered in the regional analysis.

CHAPTER II - DESCRIPTION OF THE ENVIRONMENT - (Pages R2-1 thru R2-128)

<u>Vegetation (Pages R2-38 thru R2-43)</u>

5 A reference to pertinent literature should accompany the statements (page R2-38) alluding to the influence of fire on the region's vegetation. More quantitative data (dominance, density, etc. by important species) should accompany the qualitative descriptions of vegetative types given. A complete list of species which occur or are thought to occur in the region should be presented within the text or appended.

44

Mr. Daniel P. Baker Page 3 January 9, 1979

6 Figure R2-19 (page R2-39) is supposed to illustrate playa grassland, *yet the caption reads "sagebrush-grass vegetation type". Pages R2-40 and R2-41 appear to be out of sequence; they are unrelated to vegetation.

<u>Fish and Wildlife (Pages R2-43 thru R2-47)</u>

7 * A tabular format would have been preferable for listing wildlife species associated with each habitat type. Some quantitative habitat affinity data should have been included (i.e., what percentage of the mule deer in the region occur in riparian areas?). This can be determined from population density and habitat type information.

8 * A complete list of vertebrates which are thought to occur in the region should be within the text or appended.

9 * Several common names given (page R2-43) are insufficiently specific, i.e. chub, bass, meadowlark, chickadee, and avocet. The American Ornithologist's Union has published standardized common names which are used by most ornithologists. They should also be used in environmental impact statements. Several important species have been omitted from their primary habitat types or omitted completely. These include sharp-tailed grouse from sagebrush-grass and riparian; wild turkey from riparian; bobcat from sagebrush-grass, riparian, greasewood, and ponderosa pine; mountain lion from ponderosa pine; and Canada goose from riparian. Species listed for aquatic habitats in the region should include the plains killifish, creek chub, sand shiner, yellow perch, walleye and brown trout. Flathead chub and goldeye were improperly listed. Both occur in the region.

10 Page R2-44 shows playa grassland covers 250 acres. Map #5 shows about **two townships of this type.

11 Map 7 (Appendix A) should show sharp-tailed grouse dancing grounds, wild turkey distribution, and distribution of important mammalian predators. Distribution maps for sharp-tailed grouse, gray partridge, sage grouse, pheasant, and wild turkey were provided to the Buffalo Resource Area Office of the Bureau of Land Management in November. These maps were not available for the Draft ES, but should be included in the final statement. There is a new sage grouse strutting ground in Section 27, T37N, R75W, about one mile northwest of one indicated in Map 7 along the upper Dry Fork of the Cheyenne River.

12 * We question the validity of the antelope and mule deer density data in Table R2-9 (page R2-46). Some density data in the table are based upon inaccurate data used in earlier site-specific impact statements. Inclusion of those data here merely perpetuates this inaccuracy. For example, antelope density on the Caballo Mine is given as 10.65 antelope per square mile. Recently (August, 1978) an aerial trend count made by our Department found 15-20 antelope per square mile on that site. The validity of the DES data must be questioned when the antelope density on the Eagle Butte Mine site is 67.0 antelope per square mile, while on the adjacent Rawhide Mine, it is only 6.0 per square mile. Similar inconsistencies appear in the deer data. In the absence of information showing factors attracting antelope to the Eagle Butte site or keeping them from the Rawhide site, we assume the data are in error.

44

Mr. Daniel P. Baker Page 4 January 9, 1979

Recreation Resources (Pages R2-55 thru R2-69)

Hunting (page R2-55)

13 * No mention is made in this section of the economic importance of hunting in the Eastern Powder River Basin. A quantitative estimate of the amount of revenue generated within the region by antelope, deer, elk, bird, and small game hunters should be presented. The revenue generated in license fees to the Wyoming Game and Fish Department by hunting in the region should be included, as well as the percentage of lost income as a result of mining.

14 Mention should be made of the fact that the scarcity of public land in the region is a serious hindrance to hunting recreation. Less than 25 percent of the region is accessible for public hunting. The demand for hunting in the region is such that trespass and guide fees are now a significant income source for many landowners. The scarcity of public hunting and increasing use of public lands in Sheridan, Johnson, and northern Natrona counties is perceived negatively by many residents who hunt the region.

Winter Activities (page R2-64)

15 No mention is made in this section of the recreational or economic importance of trapping in the region, particularly trapping of predators such as bobcat and coyote.

CHAPTER IV - ENVIRONMENTAL IMPACTS OF REGIONAL DEVELOPMENT (Pages R4-1 thru R4-58)

Water Resources (Pages R4-17 thru R4-23)

Groundwater (Pages R4-17 and R4-18)

16 Effects of groundwater disturbance on stream flows, subsurface water levels and riparian vegetation are not adequately addressed. Local reversal in flow, whereby recharge areas would become discharge areas, is mentioned. The environmental statement also acknowledges that original groundwater movement would not be restored by reclamation. Furthermore, the statement mentions that ranchers have reported adverse effects from mining and milling on stream reaches with perennial flow and that at least one well has ceased flowing. These factors point to the importance of defining cumulative effects of mining on groundwater as it relates to streams prior to mining.

Vegetation (Pages R4-23 thru R4-26)

17 Only direct impacts on vegetation are presented in this section. Other impacts which should be discussed quantitatively include losses due to decreases in surface and subsurface water, losses due to dust deposition, and losses due to decreased soil productivity. An additional table to Table R4-G should present acreages replaced by habitat type. This would enable the reader to assess the ability of reclamation to restore pre-mining vegetative communities and return the land to pre-mining uses.

44

Mr. Daniel P. Baker Page 5 January 9, 1979

18 The possible loss of vegetation and impacts to subsequent consumers due to heavy metal accumulation from mine spoils should be re-emphasized in this section.

19 A quantitative estimate of losses of aquatic vegetation should be presented.

20 No estimates are presented here of the time necessary to replace pre-mining vegetative diversity.

Fish and Wildlife (Pages R4-26 thru R4-28)

21 * Table R4-7 does not adequately represent expected losses. We question the validity of game mammal densities used, and thus the validity of this table. Sage and sharp-tailed grouse losses should be estimated.

Habitat Loss (Page R4-26)

22 * Along with direct habitat losses will be some very serious indirect losses. According to Map 1, Appendix A, planned developments in the region will occur in a narrow strip beginning near Antelope Creek and extending nearly to a point north of Gillette, a distance of approximately 65 miles. This strip, with associated roads, railroads, and other support facilities, serves as a barrier to east-west movement by terrestrial wildlife making daily and seasonal movement to areas of preferred habitat difficult and significantly decreasing the value of that habitat. Each site-specific EIS written in this region has reported that wildlife would be "displaced" to adjacent areas until mining and reclamation for that specific mine was complete. No consideration was given to the fact that there are so many adjacent mines in the region that there is little room for displacement.

Carrying Capacity Loss (Page R4-26)

23 * Carrying capacity losses in aquatic and terrestrial systems should be presented separately in this section to enable the reader to more adequately assess impacts to each.

24 * Only direct losses of carrying capacity are considered. Indirect losses due to movement barriers, disturbance by human activity, and urban growth should be discussed as well.

Fish and Wildlife Population Losses (Pages R4-26 and R4-28)

25 Fish - Only habitat losses are discussed in this section, not population losses. Quantitative population loss estimates should be presented.

26 * Wildlife - Some estimates of wildlife losses due to illegal kills, automobile collisions, predation by pets, and powerline mortality should be presented.

27 * We do not believe that the sage thrasher will be significantly affected. We saw the sage thrasher in the region but it was not censused in any of our bird surveys in 1978. More likely to be affected are Brewer's sparrows (*Spizella breweri*) or lark sparrows (*Chondestes grammacus*).

44

Mr. Daniel P. Baker Page 6 January 9, 1979

28 * Losses of sage grouse, waterfowl, and sharp-tailed grouse should be estimated and presented. We understand that these are now being estimated by the EIS team.

29 * No mention is made of the increase in wildlife damage to nearby croplands when wildlife are displaced by development. No mention is made of wildlife losses due to water quality or quantity degradation, such as the elimination of point-sources of water, heavy metal contamination, and loss of habitat due to surface or subsurface water loss. A reference should accompany the estimates of losses of non-game mammal species. Estimates of losses of mammalian predators should be presented.

30 * Mammals-Endangered and/or Threatened - The statement, "The black-footed ferret or its habitat is unlikely to be affected by development in the region because prairie dog towns are not found on or near the sites being developed", is inaccurate. Several prairie dog towns have been located on or very near Peabody Coal Company's North Antelope and Rochelle Mines, and the Wyodak Mine. Map #7 of Appendix A did not include several locations of prairie dog towns near mines or along the Burlington Northern Railroad right-of-way. Is this an inadvertent oversight of information supplied to the EIS team last year?

Recreation Resources (Pages R4-29 thru R4-33)

Hunting (Pages R4-29 and R4-32)

31 The development proposed will create a virtually contiguous strip of non-huntable lands from the Converse-Campbell county line to a point north of Gillette. Antelope and deer may concentrate on these lands temporarily during the hunting season, decreasing their availability for harvest, reducing hunter success, and reducing control of the antelope populations in local areas. Creation of this strip will further increase the demand for hunting on severely limited public lands in the region.

CHAPTER V - UNAVOIDABLE ADVERSE IMPACTS.... (Pages R5-1 thru R5-3)

32 * One of the most important impacts regional development will have on the wildlife resources of the Eastern Powder River Basin will be the removal of a significant amount of sagebrush-grass habitat. This habitat will be replaced by a topographically homogeneous grassland community lacking the habitat diversity necessary to support the wildlife dependent on the pre-mining environment. The importance of topographic and habitat diversity should be stressed here. The presence or absence of habitat diversity on reclaimed lands will determine the long-term effect of development on wildlife in the region.

33 * No mention is made of the significant impact on wildlife of barriers such as fences, roads, and railroads, which preclude daily or seasonal movement. The barrier to wildlife movement created by the development of nearly contiguous sites over a distance of over 60 miles should be discussed.

44

Daniel P. Baker Page 7 January 9, 1979

34 * As noted in Chapter II, we question the density data used to estimate numbers of wildlife lost, particularly numbers of antelope and deer. Sage and sharp-tailed grouse losses should be estimated and presented.

CHAPTER VI - RELATIONSHIP BETWEEN SHORT-TERM USES.... (Pages R6-1 and R6-2)

35 * The key to successful revegetation for wildlife is diversity. The loss of vegetative diversity on reclaimed lands, and thus, the loss of obligate fauna for a period of 30 years is not a short-term use. We see no enhancement of "productivity as measured in benefits to people" associated with the permanent loss of 2,200 acres of wildlife habitat. Many people believe that viewing wildlife and hunting are benefits.

36 * There is no evidence to support the statement, "Once reclamation is completed, repopulation, at least by small mammals and birds, is expected to be rapid". Repopulation is likely to occur slowly and with significant decreases in density and species diversity.

CHAPTER VII - IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS.... (Page R7-1)

37 * Quantitative estimates of wildlife losses due to loss of water holes and expansion of urban areas should be presented.

38 * Again, we question the estimated losses of antelope and deer. Sage grouse, sharp-tailed grouse, waterfowl, and mammalian predator losses should have been estimated.

39 * An estimate of wildlife losses due to illegal kills, movement barriers, and vehicle collisions should be presented.

CHAPTER VIII - ALTERNATIVES (Pages R8-1 thru R8-94)

Regional Alternatives (Pages R8-1 and R8-2)

Fish and Wildlife Mitigation Alternatives

We support all three alternatives.

No Action Alternatives (Pages R8-2 thru R8-45)

Vegetation (Pages R8-7 and R8-28)

40 There should be a table here that illustrates acreages lost and acreages reclaimed by habitat type. A firm estimate of the time necessary to re-establish pre-mining vegetative composition and diversity should be presented. Until wildlife habitat on reclaimed areas equals pre-mining conditions, wildlife density and diversity will remain decreased. Grazing of reclaimed areas should not be permitted until plants achieve sufficient vigor to withstand it. Losses of vegetation due to road and coal dust should be quantitatively estimated.

41 No section on wildlife impacts associated with the "no action alternative" (low-level scenario) has been presented.

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High-Level Scenario (Pages R8-45 thru R8-94)

Vegetation (Page R8-72)

42 Again, there should be a table here that shows acreages lost and acreages reclaimed by habitat type.

Fish and Wildlife (Page R8-72)

43 * Impacts on waterfowl, sage grouse, and sharp-tailed grouse should be quantitatively estimated and included here.

44 * If losses of aquatic habitat will increase five-fold above the low-level scenario, then impacts on species dependent upon riparian habitat will be significant. These losses should be estimated.

45 * Non-game mammal losses should include estimated losses of mammalian predators.

46 * Development associated with the high-level scenario is likely to increase wildlife damage to crops as big game are displaced from mine sites onto nearby private lands.

47 * The degree of development associated with the high-level scenario may have a negative effect on wildlife greater than the habitat loss. Development, in this case, creates an extremely formidable barrier to wildlife movement within the region. This barrier, made up of mines, power plants, and other developments with their associated roads, railroads, power lines, and other support facilities, extends from Glenrock north to Spotted Horse—a distance of over 120 miles. This barrier could effectively bisect wildlife distribution in the Eastern Powder River Basin. It could prohibit seasonal movement to preferred habitat, and significantly impede movement to escape winter storms. Such a barrier could cause catastrophic losses to antelope populations.

Recreational Resources (Page R8-74)

48 Development predicted by the high-level scenario could have serious effects on hunting in the region. The barrier to movement created by the cumulative effect of numerous mines, plants, and associated facilities may significantly decrease numbers of huntable game due to population losses. In addition, it is possible that the large tracts of non-huntable lands will concentrate deer and antelope during the hunting season, making them unavailable for harvest and decreasing hunter success. The addition of non-huntable areas will result in additional demand for hunting on limited public lands.

SUMMARY

This regional analysis of development in the Eastern Powder River Basin could be improved by additional and improved data on vegetation and wildlife. It underestimates the aesthetic and economic importance of the region's biota. It neglects cumulative and indirect losses to vegetative communities and

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obligate fauna. It fails to adequately discuss the possible changes from pre-mining to post-mining flora and fauna. The use of questionable data has resulted in underestimation of wildlife-related impacts. We presume that this will improve as site-specific data collected during the Eastern Powder River EIS contract are included in the Final EIS.

PART II - SITE-SPECIFIC ACTION (Chapters BU1 thru BU9)

CHAPTER I - DESCRIPTION OF THE PROPOSAL (Pages BU1-1 thru BU1-23)

Proposed Action (Pages BU1-1 thru BU1-20)

Surface Facilities/Support Developments (Pages BU1-2 thru BU1-10)

49 Descriptions of facilities, roads, and railroad spurs within antelope and mule deer range should include fence locations and design. Fences constructed should conform to Wyoming Game and Fish Department Guidelines.

Mining and Process Procedures (Pages BU1-10 thru BU1-15)

50 We recommend that soil not be stockpiled for more than a few months. Should longer stockpiling be necessary, plant species for temporary stabilization should be selected for establishment vigor and lack of persistence. Many species such as crested wheatgrass are undesirable as permanent cover but often used for temporary stabilization. Seeds of such species are thus introduced onto reclaimed areas via stockpiled topsoil.

Reclaimed Activity (Pages BU1-17 thru BU1-23)

51 The applicant proposes to reclaim surface-mined wildlife habitat for use as livestock grazing land. The minesite is classified as yearlong antelope range and yearlong mule deer range. It supports a wide variety of game and non-game mammals, birds, and other vertebrates. If this area is reclaimed only for livestock grazing, with "some areas...for wildlife use", we believe the applicant may be in violation of the Surface Mining Control and Reclamation Act (SMCRA) of 1977 due to the change in land use.

52 The vegetative species planned for reclamation are unsatisfactory. We do not support the use of non-native species in re-seeding wildlife habitat. Species such as sainfoin, cicer milkvetch, and caragana are undesirable unless they were present before mining. Wheatgrasses are of limited value to wildlife. More native grasses and certainly more shrubs (particularly *Artemisia* spp.) should be planted. Greater vegetative diversity is needed than will be established by the proposed seeding mixture. The proposed mixture will replace a primarily sagebrush-grass site with grassland vegetation.

CHAPTER II - DESCRIPTION OF THE ENVIRONMENT (Pages BU2-1 thru BU2-33)

Water Resources (Pages BU2-8 thru BU2-12)

Groundwater (Pages BU2-8 and BU3-18)

53 Effects of mining on municipal water supplies are presented, but effects on stream flows, subsurface water levels and riparian vegetation were ignored.

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Surface Water (Page BU2-12)

54 A map showing wildlife watering sources should be presented, as well as a discussion of the importance to wildlife of the pools along Rawhide Creek, the six wells, the five reservoirs, and any other water sources should be included.

Vegetation (Pages BU2-12 and BU2-13)

Terrestrial Vegetation (Pages BU2-12 and BU2-13)

55 Additional quantitative data should be presented for each vegetative type, including density, dominance, and frequency for important species within each type. This information is extremely important for comparison of pre-mining and post-mining environments.

Fish and Wildlife (Pages BU2-13 thru BU2-16)

56 * The most obvious deficiency within this section is the absence of site-specific data. Information collected by the Wyoming Game and Fish Department (under BLM contract) should be presented in the final EIS. It would be much better if publication were delayed until data were available.

57 * A complete list of vertebrates known or thought to occur on the site should be presented.

Wildlife species important in the big sagebrush habitat type

58 * We suggest the addition of vesper sparrow and northern grasshopper mouse, and the deletion of sage thrasher. Within the silver sagebrush type, we recommend the addition of vesper sparrow, Brewer's sparrow, and western meadowlark, and deletion of horned lark. Within the riparian type, we recommend the addition of mourning dove, western meadowlark, red-winged blackbird, cliff swallow, barn swallow, and meadow vole. Quantitative habitat affinity information should be presented.

59 * Non-game bird density data from K. Oakes work at Coal Creek is not representative of the Buckskin site. Nearly all densities we calculated during our bird census work on the Buckskin site were more than twice 1.57 birds per acre.

60 * Raptor nesting has been observed on the Buckskin site. One active red-tailed hawk nest was observed there and two great horned owls nested on-site in 1978.

61 * Mourning dove density on the Buckskin site was 14-29 per square mile in July, 1978. Doves and waterfowl are not the only game birds on the site. Gray partridge, sharp-tailed grouse, and sage grouse were all observed on or near the Buckskin site in 1978.

62 * Density data for game and non-game mammals are presented here with no reference to the source of the data.

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63 * Winter densities of antelope and mule deer should have been presented. During the winter of 1976-77 there were at least 500 antelope in the general area of the proposed Buckskin mine site. These antelope moved into the area to five miles southwest of the proposed mine site, their movement stopped by Rawhide Village Park. Approximately 200 remained north of the proposed site on the Morrel Ranch. While deep, crusted snow persisted, the mine site and vicinity provided critical winter range for these antelope. Those 200-300 antelope which moved south of the proposed mine site crossed the proposed mine access road, the mine site and/or the proposed railroad spur route. To prevent antelope from backing up against access road and railroad spur fences, those fences should be constructed to allow antelope passage (Wyoming Game and Fish Department Guidelines for Fence Construction of Livestock-Antelope Range). Mule deer movement occurs in the rough hills between the proposed Buckskin mine and Wyoming Highway 59, in the proposed path of the railroad spur. This area is seldom used by antelope. The railroad spur should remain unfenced or fence construction should follow Department guidelines for fencing on livestock-deer range to minimize hazards to mule deer movement.

Fishery (Page BU2-15)

64 * Fathead minnows were collected and identified from this portion of Rawhide Creek on October 10, 1978.

Amphibians and Reptiles (Page BU2-16)

65 * Are density estimates used here documented?

Recreation Resources (Page BU2-16)

66 There is no mention of the importance of hunting to the recreational needs or economic base of Campbell County, and no mention of the scarcity of public land for hunting.

67 No attempt is made in Chapter II to recognize wildlife habitat as a legitimate and important use of the site. Failure to recognize this existing land use will result in misdirected reclamation planning, thus limiting wildlife use of the post-mining environment.

CHAPTER III - ENVIRONMENTAL IMPACTS OF THE PROPOSAL (Pages BU3-1 thru BU3-46)

Topography (Pages BU3-7)

68 Estimates of the effect on the flora and fauna of lowering the entire minesite by 75 feet should be presented.

69 Figure BU3-9 (Page BU3-16) is extremely misleading. It gives the casual reader the impression that the reclaimed minesite will blend in well with surrounding areas. However, the contour line interval within the boundary of the site is 2 feet, while outside the boundary, it is 20 feet. This figure should be corrected, explained more thoroughly within the text, or deleted.

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Soils (Pages BU3-17 and BU3-18)

70 How long will it take to redevelop soils on-site? If the productivity of reclaimed soils limits the effectiveness of revegetation, then steps should be considered to improve that productivity. The proposed action should not limit post-mining land use by decreasing the ability of the site to produce vegetation. If the site cannot be reclaimed to support the previous carrying capacity and its original use it should not be mined.

Water Resources (Pages BU3-18 thru BU3-24)

Groundwater (Pages BU2-8 and BU3-18)

71 Effects of mining on municipal water supplies are presented, but effects on stream flows, subsurface water levels and riparian vegetation were ignored.

Surface Water (Pages BU3-23 and BU3-24)

72 If watering sources now available on the site are not restored during mining and no new sources are made available, a serious loss of habitat will occur. Water sources on the site after mining should be equal to those present before mining.

Vegetation (Pages BU3-24 thru BU3-27)

73 * Impacts of the proposed action on vegetation are likely to be very serious. According to information presented in Chapter II, approximately 65 percent of this site is big sagebrush and silver sagebrush habitat types. Proposed reclamation plans will replace this with a grassland community, as noted in Chapter I. In addition, a 13 percent decrease in soil productivity may limit the success of revegetation.

74 The impacts of dust deposition and surface water losses on vegetation should be discussed quantitatively in this section.

75 In conjunction with Table BU3-11 (Page BU3-26) should be another table illustrating acreages reclaimed by habitat type. The reader could then more clearly assess the impacts of the proposal on vegetation.

76 * If aquatic vegetation cannot be restored along the drainages of Spring Draw and Rawhide Creek, habitat for waterfowl and non-game shorebirds will be seriously depleted on this site.

Fish and Wildlife (Pages BU3-27 thru BU3-29)

77 * As noted in our comments on Chapter II, the absence of site-specific information is conspicuous. The lack of well-collected, site-specific inventory data makes an accurate assessment of the impacts of the proposed action impossible.

Fishery (Page BU3-27)

78 * As fish have been documented in Rawhide Creek, mining of this site would eliminate any fish present. Degradation of the Rawhide Creek drainage could also adversely affect fisheries habitat downstream in the Little Powder River.

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79 * The statement (Page BU3-27) that "...mule deer movement is not restricted by fences" is inaccurate. Mule deer movement, particularly during winter and spring, is often seriously impeded by fences. Any fences constructed on the site should conform to Wyoming Game and Fish Department guidelines for fencing on antelope and mule deer range.

80 * We disagree with the "minor" impact predicted on non-game and game birds in Table BU3-12 (Page BU3-28). The loss of sagebrush on the site and its subsequent replacement by grassland, will seriously affect birds who depend on this habitat type for food, cover, and courtship display sites. Such an impact on this site is major. We disagree with the "minor" impacts predicted on non-game and game mammals. Mammal populations are often less dense and certainly less diverse in grassland than in sagebrush-grass habitat. Fishery impacts are listed as "none". This is incorrect as there would be "minor" impacts on non-game fisheries. Serious reductions in density and diversity of most species may be expected if reclamation plans now proposed are carried out.

81 * Population losses shown in Table BU3-13 (Page BU3-29) are not accurate for the Buckskin site. The estimated 1.57 songbirds per acre is too low, as we previously mentioned. The estimated 130.5 doves per square mile on the site is too high. We found 14-29 per square mile. Waterfowl losses should include all species, rather than just mallards. Losses of grey partridge and sharp-tailed grouse should be included.

82 * Impacts on predators on the site have been underestimated. Impacts on prey species (small mammals, song birds, and invertebrates) mainly determine impacts on predators. If prey species decline in abundance and variety so will predators. These losses will occur if revegetation for wildlife is not accomplished.

Recreation Resources (Page BU3-30)

83 We disagree with the statement that "On the Buckskin site itself, recreational opportunities are negligible now, and would be little changed by mining". Although the site is privately owned, the opportunity to obtain permission and hunt, photograph, or view wildlife does exist. This opportunity will be seriously reduced after mining.

84 Nowhere in Chapter III is there any mention of impacts on land use. Unless wildlife habitat is recognised as an existing use, the proposed action will have very significant effects on land use. The present use of this land is wildlife habitat and livestock grazing. It should be reclaimed for those uses.

CHAPTER IV - MITIGATING MEASURES (Pages BU4-1 thru BU4-20)

We support the placement of rockpiles to provide some topographic and habitat diversity. They will not replace existing habitat, but they will increase the cover available in the proposed post-mining grassland habitat.

We support the restoration of reservoirs to provide wildlife watering sources, paving of the access road to reduce road dust and deposition of

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dust on vegetation, and the use of fences designed to prevent wildlife losses, and suggest conformation to Wyoming Game and Fish Department guidelines on fencing.

We suggest the following procedures be added to the list of mitigating measures:

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* 1. The use of snow fencing to increase available moisture on revegetated areas.
* 2. Soil surface treatment (tillage, pitting, gouging, etc.) to increase survival of young plants in revegetation and catch snow, increasing available moisture.
* 3. Mulching to provide protection for young shoots and to increase available moisture.

4. The use of topsoil or vegetation patches as methods of re-establishing native vegetation. We recommend that a significant portion of the vegetation cover on the reclaimed area be native shrub species preferred by wildlife. The use of commercially available shurb seedlings should be considered.

5. The use of buses to transport employees. This may reduce illegal kills and wildlife-automobile collisions.

CHAPTER V - UNAVOIDABLE ADVERSE IMPACTS (Pages BU5-1 thru BU5-2)

86 * Greater emphasis should be placed on the impacts to wildlife habitat associated with the proposed action. Existing diverse wildlife habitat will be replaced by a grassland monotype of limited value to wildlife. Aquatic habitat along Rawhide Creek and Spring Draw will be destroyed and not adequately reclaimed. Fauna associated with both terrestrial and aquatic habitat will be lost, and pre-mining land uses will not be restored.

87 If a 40-240 acre lake will eventually form on the site, and that lake is not of greater value than the terrestrial habitat lost, the pit should be filled.

88 * We question the accuracy of the wildlife numbers estimated to be affected by the proposed action.

CHAPTER VI - RELATIONSHIP BETWEEN SHORT-TERM USES...(Page BU6-1)

89 * This section seriously underestimates the long-term significance of the loss of floral and faunal diversity on the site. Habitat for all species which depend on the diverse communities on the site will be seriously degraded. Until pre-mining vegetative composition is restored on the site, we do not believe that most species will reinhabit the area at levels comparable to those prior to development.

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CHAPTER VII - IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS...(Page BU7-1)

90 This section does not adequately present irreversible, long-term losses to vegetative diversity and wildlife populations associated with the proposed action. We believe that losses to nearly all wildlife species will be greater than Table BU3-13 indicates. We do not believe that wildlife populations will reattain pre-mining levels, given proposed reclamation plans. The loss of flora and fauna on the Buckskin site will be irreversible and irretrievable unless the area is recognized as wildlife habitat and reclaimed as such.

CHAPTER VIII - ALTERNATIVES...(Pages BU8-1 thru BU8-2)

...Approve Mining and Reclamation Plan After Modification (Pages BU8-2 and BU8-3

Fish and Wildlife Mitigation Alternatives

We support all three mitigations proposed in this section and suggest further steps be taken to lessen impacts (see above, Chapter IV - Mitigating Measures).

SUMMARY

This is a poor site-specific assessment, largely due to lack of data. We assume that this will be improved in the Final EIS. This assessment fails to recognize an important use of the area (wildlife habitat), proposes reclamation practices of questionable benefit to wildlife, and underestimates serious long-term consequences of the proposed action. We do not believe it constitutes an adequate assessment of environmental impact because it is incomplete.

If we can be of further assistance on this project, do not hesitate to contact us.

Sincerely,

W. DONALD DEXTER, ASSISTANT DIRECTOR
WYOMING GAME AND FISH DEPARTMENT

WDD/HBM/mlr

cc: State Planning Coordinator
Game Division,
Fish Division
Communications Division
Planning Division

Letter 44 Responses

* Information requested in this comment is included in the final ES. The fish and wildlife sections, in particular, were extensively revised in accordance with data collected by the Wyoming Game and Fish Department for BLM.

** The final ES has been corrected.

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AtlanticRichfieldCompany

Synthetic Crude and Minerals Division
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D. K. McSparran
Manager

January 12, 1979

Julie Elfving, Team Leader
Bureau of Land Management
951 Union Boulevard
Casper, Wyoming 82601

RE: Draft Environmental Statement--Eastern Powder River Coal

Dear Ms. Elfving:

Although the period for comment has expired, we are submitting comments which we feel should be considered if time allows. We feel that there are some incorrect or incomplete statements in the draft. Our comments will be given by page and paragraph.

1 Page R-36 - The section entitled "Vegetation and Wildlife" contains a statement that the Bald Eagle Protection Act of 1969 prohibits mining operations in any area where such activities would molest or disturb bald and/or golden eagles and/or their nests.

RESPONSE--Public law 95-616 which was passed by Congress late in 1978 and entitled "Fish & Wildlife Improvement Act of 1978" contains a provision in Section 9 which allows the Secretary of the Interior to promulgate regulations for the taking of golden eagle nests which interfere with resource development or recovery operations. This change should be noted in the final statement.

2 R3-11 entitled "State of Wyoming" - This section contains a statement that the Department of the Interior is negotiating a cooperative agreement with the State of Wyoming.

RESPONSE--This agreement has now been signed and should be so noted in this section.

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Julie Elfving, Team Leader
January 12, 1979
Page 2

3 Page R4-26 entitled "Fish & Wildlife Population Losses" - There is a statement that Little Thunder Creek contains non-game species of fish including Carp, White Sucker, etc.

RESPONSE--This is misleading since Little Thunder Creek is ephemeral and, therefore, could not support a fish population on a continuous basis.

4 Page R8-2, section entitled "Fish & Wildlife Mitigation Alternatives" - The statement is made that the goal of reclamation should be to achieve the highest possible wildlife carrying capacity at the earliest possible date regardless of cost.

RESPONSE--This statement appears to set wildlife carrying capacity as the highest priority in reclamation of the lands that have been mined. We do not agree with that statement. The lands at present are subject to multiple use with livestock grazing being the first priority because of its impact on the local economy of the area. We believe that the use after reclamation should be consistent with the use prior to mining, and therefore, the first priority would be to reestablish domestic livestock grazing while at the same time attempting to reestablish wildlife carrying capacity--but certainly not regardless of cost.

5 Page R4-35 entitled "Livestock Grazing" - The statement is made that there is a potential for chronic poisoning of livestock from heavy metals released during mining. This is followed by a statement that neither the ground-level concentrations of gaseous pollutants nor deposition rates of particulate pollutants are known. Therefore, the extent of any adverse effects on domestic and wildlife grazers cannot be predicted.

RESPONSE--These statements were taken from a report completed in 1976 for Atlantic Richfield. At the time the work was done, there was little information available. Currently, there are several mines operating in the area, and there is no indication of any poisoning by the release of heavy metals. In addition, considerable work has been done in air quality modeling including deposition in the Eastern Powder River Basin by companies applying for mining permits in that area.

The above subject is also discussed on page R8-28.

Sincerely,

D. K. McSparran

D. K. McSparran
Manager

DKM:cae

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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

JAN 19 1979
Ref: 8W-EE

Coal E. S. Team
951 Union Boulevard
Casper, Wyoming 82601

Attn: Ms. Julie Elfving

Dear Ms. Elfving:

The Region VIII office of the Environmental Protection Agency has reviewed the draft environmental impact statement for the Eastern Powder River Region of Wyoming and the proposed mining and reclamation plan for the Buckskin mine and offers the following comments for your consideration.

1 1. We have noted Interior Department's commitment to revise mining plans in final EIS's in accordance with the Office of Surface Mining's (OSM) regulations and prior to such approval, Interior shall submit a supplemental EIS for those plans that have undergone significant change in the environmental impacts of the proposed mining operation. However, we strongly suggest that revisions to the proposal be completed before the final EIS is published.

2 2. The DES contains inadequate analysis with respect to the identification of a potential alluvial valley floor in Rawhide Creek. The EIS should include more complete information with respect to alluvial valley floor identification. If such an area is present on or near the Buckskin Mine site, the presence and extent of farming and the essential hydrologic functions of such areas should be documented. This should include a determination by the Soil Conservation Service as to the presence or absence of prime farmland in the region and specifically on the Buckskin site.

3 3. In general, the data presented on the flow conditions in the various aquifers is incomplete. It does not provide an adequate picture of the impacts on the individual aquifers. There is a need for some specific data on each individual aquifer in order to present a better picture of the before mining flow conditions. This information should then be used to establish a more detailed description of the post mining flow pattern.

46

4 4. Tha draft EIS did not contain any discussion on the prectices or controls used to minimize generation of fugitiva dust.

According to the procedures EPA has adopted to rate the adequacy of dreft environmental impact statemanta, the dreft EIS for the Eastern Powder Rivar Region will be listed in the Federal Register es ER-2. This means that we have significant rasarvations concerning the environmental affecta of some of the discussed aspects of the draft EIS. Further, we believe the draft EIS doas not contain sufficient information for either othar agancies nor the public to fully assess environmantal impacts. We are requesting that you provida EPA and others with the additional information requasted in this latter and the attached detailed commenta in the finel EIS.

We appreciete the opportunity to review this draft EIS and request that you provide us with five copies of the finel EIS for our review. If you have any questions, please contact Dennis Sohocki of my staff et (FTS) 327-4831.

Sincerely yours,

Alan Merson
Regional Administretor

Enclosure

46

Regional Groundwater Comments:

8. The description of the ground-water conditions in tha Foxhills Sandstone, the Lanca Formation, tha Fort Union Formation and the Wasateh, is inadequete. Tha water lavel data, for instance, ie not very meaningful since the watar levels used were from walle which do not necesserily panatrete equivalant units. Tha resulting map could be in arror by several orders of magnitude. It is true that thera ie very littla data on walls which penatrate only one formation, but tha proposed mining of the coal is of such an extant that it would seem justified to put down e fairly extansiva series of test holas to ellow a better picture of tha ground-water movemant in each of the units to be established. Test wells could
11 penatrate all units with blank casing and then perforated starting at tha bottom. The unit in question could ba tested and then sealed with concrete allowing the ovarlying unit to be tested after it is perforeted with no interferance from tha lower or upper units.

Date should be collected that will allow a much better picture of the major sources of recharge for the verious units and their reletionship to the existing water quelity end the direction of groundweter movement. This type of study should be plenned in conjunction with eny future regionel EIS's in this area that might result from the proposad Federal coal laasing program.

9. There should be an improved description done on the existing water quelity in the verious formations. The data on wetar quality would appear to be more related to the particular perforated intervel of e
12 given eempling well than the geologic conditions of a specific formation. It would appear to be more difficult to make a meaningful statement about post mining groundweter quality changes without heving a good pra-mining date base that is represantative of individual aquifers.

10. The eection on the impact of mining on the groundwetar quelity of the underlying units is inadéquate. It is difficult to imagine that the smashed up waste rock will produce water that is equivalent to that found in the alluvium. Grinding up what was e consolidated formation greatly increasas the potantiel for various elements to go into solution. It would seem appropriate to present a little data on
13 the type of composition of the host rock and have an analysis es to the possible leachate that could be generated. There should be a discussion as to the possibility that mining could create a lerge regional depression which could have water etanding in it. If such an occurranca is possible, then a discussion of the resulting groundwater and surface water quelity afforts would be in order.

There is no reliebla data presented to substantiate the claim that various matals which may go into solution es water moves through the

46

Detailed Comments

5 1. We are completing the Region VIII Beat Aveilable Control Technology policy for strip mines and a copy will be sent to your office in the near future. Enclosed is a copy of Region VIII's Interim Policy Paper on the Air Quality Review of Surfaca Mining Operations.

2. It is a misuse of both your tima in writing and our time in reviewing e regional EIS on e mine plen that is not responsive to current federal regulations. It is eleo unacceptable as a means of complying with the National Environmental Policy Act of 1969.

6 3. The determination made on BU 2-17 that "prime fermlend es dafined by SMCRA does not exist on the sita," appears to be prematura, since such e determinetion should be made by the Soil Conservetion Service.

4. Given the loss in soil productivity to 87% of present levels (BU 3-18 and BU 4-17), the potentiel exposure of materiel containing chemicals harmful to plente and animals by mining (BU 3-17), the arid nature of the region end its cyclical 1 yr, 2 yr, and 3 yr long droughts occuring every 7 yaars, 25 years, end 143 years reepectively (BU 2-1),
7 and the present topsoil depth of only 18" with potential losses if exposed during floods (BU 4-17), it saems questionabla whether long-term reclamation will, in fact, be possible. It appaars that since "eny soil amendments such as fertilizer or organic matter can only result in a temporary increase in productivity" BU 4-17) further measures must be taken to insure not only ehort-term, but long-term reclamation.

8 5. Thera hae not been sufficient study done of Rawhide Creek to determine if it is an elluvial velley floor or not. If Rewhide Creek is an elluvial valley floor, the contours for reclamation discussed may not be acceptable. Also, the planned divereion for Rawhide Creek may not be adequete to handla tha 100-year flood.

6. Would the ponding discussed on BU 3-24 be acceptable to the Wyoming Departmant of Environmental Quality (DEQ)? Given the potential leaching characteristics of such ponds and its possible effects on water quelity, it must be remembered that under the interim OSM regulatione, no interior
9 drainage is permitted unless the water quality and quantity are suiteble for post mining use. Therefora, we suggest that the post mining topography be altered to eccount for subsidence and aliminete these internal drainages. Altarnatively, if one is formed or approved by the Wyoming DEQ, no additional ponds should be ellowed until the water quentity and quality ere determined to ba acceptable for livastock grezing.

10 7. The BLM should pursue current information on the Buckskin mine plen that is availeble with both USGS and OSM. Additional hydrological information is contained in this new information.

46

spoils will not eventually degrede the quality of underlying formations for a larga distance. Without meaningful data on the prasent flow condition end the existing quality, it is not possible to predict the amount or rata of degredetion other than to say thet something will happen.

14 11. The final EIS should presant deteiled maps on the post mining recharge ereas and post mining flow patterns in the verious aquifers. There should be a discussion on the types of contaminates that could migrate out of tha various spoil piles and the possible rate of movement of such alements. There should elso be some discussion es to the measuras which might ba takan to minimize such movement.

Buckskin Groundweter Comments

12. The description of the flow of groundwater in the coal should be expanded. The storage coefficient for the coal seems very low to describe what the epecific field of the coal would be during actuel dewatering of the coal. We would expect e greater voluma of wetar
15 per volume of coal to drein out of the coal than 0.0006. If the storega coefficient of the coal wes obteined by pump test, it is likely that the storage coefficient reflects artasien conditions in the coal. There should be some discussion on the amount of water in storage in the coal.

16 13. Thera should ba additional data presented on the thickness and extent of the alluvial aquifar near Rawhide Creek. This should aleo include data on the depth of watar.

17 14. Thera is not enough data on the flow cheracteristics in the sendstone overburden. This should be defined in a cleerer manner end a weter table map included.

15. The section on impacts should have some explanation as to the assumptions made on tha extant of the cones of depression in the coal
18 and the elluvium. There should be a datailed description of the impect on the alluivum aquifer caused by overburden removal. In addition, it does not seem reasonabla to axpect the flow characterietics of the overburden wasta to have the same flow charecteristics as the coal, eince much of tha flow in tha coal is probably along fractures. There should ba some documentation to varify this statement.

Letter 46 Responses

1. The concerns of EPA are recognized. The ES contains a caveat which says that the plan described in the ES will be revised in accordance with Office of Surface Mining (OSM) regulations, and, when this is done, the plan will be reviewed for compliance by OSM. The caveat also states that prior to approval of a revised plan, an updated environmental assessment will be done. If there have been significant changes in the environmental impacts of the proposed mining operation described in the ES from those of the plan submitted for approval to OSM, then a determination will be made as to whether a supplemental ES will be required to comply with the National Environmental Policy Act of 1969. This procedure will allow adequate evaluation and public review of the mining and reclamation plan that has been brought into compliance with OSM regulations. This procedure is being used for the current regional coal ES and is not planned for use in future analysis of mining and reclamation plans.

2. An area of alluvial valley floor is present in and near the Buckskin Mine site (see Figure BU2-4) according to the Geological Survey (Williams 1978). The area designated as alluvial valley floor (Qfs on Figure BU2-4) is cultivated (see Figure BU2-8). The text in Chapter 2 of the site-specific analysis has been revised to indicate this, as well as the fact that the Soil Conservation Service has not made a determination that prime farmland exists on the site.

3. The concept of individual aquifers on a regional scale is misleading. Actually, the aquifers are permeable sandstone and coal beds and lenses of very limited areal extent that can be traced no more than a few miles in any direction. Disruption of a local aquifer by a coal mining operation may have little or no effect on nearby wells that tap a different sandstone lens within the same stratigraphic sequence. Although it is possible to treat the overall sequence as a generalized aquifer system, the data are not available from which to appraise the physical and hydrological properties of the individual aquifers, which, in the region, probably number in the hundreds and possibly in the thousands.

4. Fugitive dust control techniques are discussed in Chapter 4 (Table BU4-1) and Chapter 8 of the site-specific analysis. Haul roads would be stabilized either with chemicals or by watering. The access roads would be paved to reduce dust emissions.

5. Thank you for the information.

6. See response 46-2.

7. See response 14-49.

8. The alluvial valley floor question is treated in response 46-2.

The contours for reclamation would most probably not be acceptable; one possible alternative is discussed in comment and response 46-9. The planned diversion design (Shell Oil Company, May 1977) indicated a capacity to handle a much smaller flood than that from a 100-year storm. Mitigating measure (F) in Chapter 4 of the site-specific analysis discusses the Wyoming State Engineer's requirements for handling runoff from back-to-back, 100-year storms. (Unfortunately, there is no way to determine the frequency of 100-year floods; there appears to be no connection between the 100-year flood and the 100-year storm.)

9. The postmining topography could be surcharged with 3 to 10 feet of extra soil in the low areas along the stream bed to provide a guaranteed, sloped-overflow floodplain high enough to prevent formation of a depression after all settling has occurred. The text states that before any permanent impoundment can be left on reclaimed land, determinations of water quantity and quality must be made, and the impoundment must be part of the approved reclamation plan.

10. See responses 14-1 and 14-3 concerning the revised mining and reclamation plan.

11. As stated in Chapter 2 of the regional analysis, Water Resources, the Fox Hills, Lance, Fort Union, and Wasatch formations are lithologically similar and thus have similar water-bearing properties. On a regional basis, they collectively function as a hydrologic unit, exhibiting a recognizable pattern of occurrence that shows recharge areas, direction of groundwater movement, and the approximate integrated hydraulic gradient. On a local basis, all formations but the Fox Hills Sandstone are composed dominantly of interbedded sandstone, siltstone, shale, and coal beds of limited areal extent (see Figure R2-7). Individual aquifers, with the exception of the Wyodak-Anderson coal bed, probably can be traced no more than a few miles before grading laterally into siltstone or shale. Considerable question exists as to the practical, if not the economic, feasibility of attempting to test this myriad of locally permeable strata. Certainly such an undertaking is not within the scope of this ES. A well testing individual permeable zones above the Pierre Shale, such as that proposed in the comment, was recently completed by the Geological Survey near Arvada just west of the region. Preliminary data indicate that a maximum difference of head of about 50 feet was found in this hole.

12. Existing data on groundwater quality in the region currently do not permit any correlation with geologic conditions of a specific formation, or with perforated interval, depth below surface, etc., because most samples collected and analyzed in the past are not representative of single identifiable aquifers of known areal extent. Because formations underlying the region to a depth of several thousand feet are all of continental origin, the quality of water obtained from sandstone beds and lenses is generally similiar. A parallel statement can be made for water obtained from coal beds. Water quality data collected in the future can be selected to provide a good premining data base, but such an undertaking was beyond the scope of this ES.

13. Because of the characteristically low vertical permeability in the interbedded sandstone, siltstone, shale, and coal strata in the region, it is highly unlikely that the quality of groundwater in aquifers underlying the mined coal beds would be adversely affected to any measurable extent.

Observations show a wide range in water quality in the alluvial aquifers, but for the most part, water from this source is very hard and commonly contains in excess of 3,000 milligrams per liter (mg/l) dissolved solids. Similarly, leachate from spoil materials can be expected to range widely in dissolved solids concentrations, but generally should not contain more than 4,000 mg/l. Considering the region as a whole, water from the alluvium may not be significantly better than water from reclaimed spoil materials.

Analyses of the host rock alone would provide no indication of the quality of the leachate from these rocks following mining, because solubility of many chemical compounds depends on local factors such as pH, and oxidizing-reducing conditions.

The reclaimed topography is described in Chapter 4 of the regional analysis. Mine reclamation plans that greatly increase internal drainage, or create lakes on major drainages, have not been approved in the past, and OSM regulations requiring restoration of the approximate original contour should limit any such conditions in the future. It should be noted, however, that natural areas of internal drainage, some as large as a square mile, currently exist within the area of ongoing and proposed mines.

Although mine plans probably will not be approved where increased internal drainage is proposed, the possible occurrence of this problem at the Buckskin Mine site is discussed in Chapter 3 of the site-specific analysis, Water Resources.

As stated in Chapter 2 of the regional analysis and shown in Table R2-7, trace metals do not occur in significant amounts in groundwater in the region. The high pH of the water and the presence of sulfides, which inhibit the solubility of the trace metals, have been verified by all groundwater studies in the area.

14. Information from which to prepare detailed maps of postmining flow patterns is not currently available. Groundwater models being prepared independently for the Bureau of Mines and the Geological Survey should provide this information at a future date.

Data are not currently available to allow an expanded discussion of contaminants from spoil materials beyond the general discussion of salinity, trace elements, and organic compounds presented in the ES. The Environmental Protection Agency has let a contract for the design of a water quality monitoring program in the Powder River Basin. Their report is expected to be completed in March 1979.

Any measure that may be taken to minimize the leaching and movement of contaminants from spoil materials depends on local hydrologic and geologic conditions, as well as the types of contaminants present. Because of the wide variation in these factors within the region, any discussion of possible mitigating measures is beyond the scope of a regional ES.

15. The low storage coefficients reported in the ES are generally indicative of confined (artesian) conditions and are useful in predicting the spread of the cone of depression to points distant from a mine. Once mining is initiated, confined conditions change to water-table conditions, and inflow to the mine reflects the specific yield of the coal aquifer. Analyses, however, show that most water in the coal is tied up in a gel-like state and also occurs as a part of the molecular structure of the coal. Specific yields, therefore, are characteristically low and do not seem to be easily predicted from well tests. Experience shows that the specific yield of coal aquifers ranges widely depending on the amount of local fracturing, but as a rule probably does not greatly exceed 0.01.

16. To date, Shell Oil Company has not completed a comprehensive drilling program to determine local conditions of groundwater occurrence or the extent of the alluvial aquifer underlying Rawhide Creek. That data must be obtained, however, and included in the revised mining and reclamation plan that will be submitted to meet OSM regulations. The data will also be considered prior to any mining and reclamation plan approval.

17. Water-level contours in the Buckskin Mine area are essentially the same for both the coal and overburden sandstone aquifers (Figure R4-10). The small differences apparent from available data do not warrant inclusion of a separate map for the sandstone overburden for this area. Elsewhere in the region, available data are not adequate from which to prepare overburden water-level maps.

18. The text states that the lowering of water levels in the overburden (which includes alluvium) and coal aquifers would depend on the areal extent and thickness of the aquifers. These are the principal constraints used in the appraisal. No assumptions were made for local areas because of the wide variety of conditions that exists within the region.

The impact of overburden removal on the alluvial aquifer depends on local conditions and mining methods. It cannot be generalized for the region beyond the discussion presented in Chapter 4 of the regional analysis, Water Resources.

The text, based on studies by Rahn (1976), states that the reclaimed spoil would probably transmit water almost as well as the aquifers it replaces. This is not the same as concluding that the flow characteristics in the reclaimed spoil would be essentially the same as those in the coal. Flow conditions would be different, but emphasis in the ES is placed on the water-yielding characteristics of the reclaimed spoil vs. the original aquifers rather than on the detailed mechanics of how water moves through these rocks before and after disturbance.

47

Texas Energy Services, Inc.
a Kaneb company
1001 Douglas Highway • Gillette, Wyoming 82716 • (307) 682-5555

Philip L. White
Vice President

January 22, 1979

United States Department
of the Interior
Bureau of Land Management
Casper District
951 Union Blvd.
Casper, Wyoming 82601

Attn: Ms. Julia B. Elfving, Team Leader
and Associate ES Team Members

Re: Texas Energy Services' written testimony, dated November 30, 1978 - Environmental Statement, Eastern Powder River Basin Coal

By way of clarifying my January 19th conversation, with Mr Bob Armstrong, regarding our written testimony of November 30, 1978, I am submitting the following additional information in hope of delineating Texas Energy Service's position.

The intent of our November 30th, letter, attached hereto which addressed the Draft Eastern Powder River Environmental Statement was two fold. First it sought to famarilize members of the ES Team with our intent to develop the Rourke-Amax Property with the acquisition of a federal lease and inturn substantiate same. Secondly, it sought to address our exclusion from the statement as an interested firm, seeking to establish itself in the Basin.

Specifically we sought, and still seek, the following:
Delineation of our holdings on the Regional Activities, Map 1, Appendix A; Inclusion in Figures R8-10 and Table R8-26, pages R8-56 and R8-57; and elsewhere as appropriate.

As per your inquiry and my response, we did not seek then, nor do we seek now, site-specific action, environmental assessment as per Shell's plans to develop its Buckskin property addressed in the statement. In reference to site specific catagorization, we addressed same only as it pertained to our attempted designation as such in the Wyoming, Casper District, 1977 Eastern Powder River Basin MFP.

We seek to correct the above misunderstanding and secure recognition of our plans to develop the Rourke-Amax property in a manner similar to those firms which have expressed a like interest and had their plans incorporated

47

in the statement.

Our concern stems from the startup plans outlined under the preferred alternative in the draft programmatic and our interpertation of those plans. It is our understanding thet initial leasing will be based upon existing land use plans and environmental statements, specifically the Eastern Powder River Coal, Environmental Statement addressed herein.

As a small firm we can ill afford to miss out on the first lease offering some two years from now and have to await the next lease offering four years hence - a total of six years from now.

Thank you for your consideration.

Respectfully,

Phil White

Attachment

cc: J.J. Kocian
M.L. Kusin

APPENDIX B

SUPPORTING DATA

SOILS

Soil Association Descriptions

Bankard-Haverson-Kim-Riverwash-Association (No. 1)

This unit occurs as nearly-level, well-drained, deep soils on the floodplains and alluvial fans. Soils in this association developed in alluvium along sandy, shifting bottomlands and along rivers and major streams. They may occupy undulating fans, terraces, and bottomlands.

The Bankard series is on the floodplains, fans, and level terraces; Haverson soils are situated on the bottomlands; and Kim soils are found on alluvial fans below upland areas.

The soils of this association are moderately alkaline and subject to flooding during spring and early summer. They are highly susceptible to wind erosion. The acreage of this soil association is estimated to be 184,134 acres.

Razor-Shingle Association (No. 2)

This unit includes very shallow to moderately deep, well-drained, loamy, sandy, and clayey soils from sandstone and shale on sloping to steep uplands.

This association consists primarily of shallow soils and bedrock exposures on steeply sloping badlands bordering the larger streams and in areas where the bedrock has been uplifted. Shingle soils are less than 20 inches deep to shale and sandstone bedrock. Razor soils are 20 to 40 inches deep to shale or siltstone bedrock. These soils produce very little vegetation. Revegetation opportunities are very poor, and the soils are highly erodible. The acreage of this soil association is estimated to be 351,228 acres.

Renohill-Maysdorf-Ulm Association (No. 3)

This unit represents moderately deep to deep, well-drained, loamy, sandy, and clayey soils on level to nearly level alluvial fans and sloping to steep uplands.

This association consists of moderately deep soils interspersed with deep, medium to fine-textured soils. Renohill soils occur on ridgetops and ridgecrests; Ulm soils are situated on nearly level upland fans and terraces; and Maysdorf soils are found on moderately sloping upland hills and valley sideslopes.

Soils of this association are highly erodible. Productivity potential is considered moderate. The acreage of this soil association is estimated to be 378,745 acres.

Unnamed Association (No. 4)

These soils are known to be deep to shallow, well drained, loam and clay loam on gently sloping alluvial fans and sloping to moderately steep uplands.

Soil series names have not been identified for these soils; however, the following information can be assumed from their classification. These soils are considered to be mostly medium textured, including textural families of fine loamy and fine. Depth is variable, ranging from less than 20 inches to greater than 40 inches over bedrock. The clay fraction of the fine family has montmorillonitic minerology. The representative soils of this unit range from (1) Ustollic Paleargids, fine, montmorillonitic, mesic, indicating relict soils on the oldest stable erosion surfaces with fine-textured B horizons having abrupt upper boundaries, (2) Ustollic Haplargids, fine loamy, mixed, mesic, shallow, medium-textured soils less than 20 inches to soft bedrock with normal illuvial B horizons having simple morphology, and, (3) Ustic Torriorthents, fine loamy, alluvial or eolian; they have little pedogenic development. Productivity is assumed to be low to moderate; erodibility is high. The estimated acreage of this soil association is 250,382.

Renohill-Terry-Shingle Association (No. 5)

The soils are moderately deep and shallow, well drained, fine sandy loam, loam, and clay loams on moderately steep to steep uplands, ridges, and sidehills.

Renohill soils are moderately deep, fine-textured soils on ridgetops and underlain by shale. Terry soils are moderately deep, moderately coarse-textured soils occurring on side slopes and underlain by sandstone. Shingle soils are shallow and occur on steep upland ridges, usually dissected with numerous drainages and underlain with shale.

These soils are highly erodible and have low productivity potentials. The estimated acreage of the association is 280,102 acres.

Renohill-Wyarno-Cushman Association (No. 6)

These soils are deep and moderately deep, well-drained loam and clay loams on nearly level to sloping

alluvial fans and gently sloping to moderately steep uplands. They overlie interbedded sandstones, shales, and siltstone.

Renohill soils are moderately deep, fine textured, and occur on ridgetops and ridgecrests; Wyarno soils are deep, well drained, and formed in alluvium; and Cushman soils are moderately deep and occupy moderately steep upland positions underlain by soft sandstone at depths of 30 inches. Productivity potential is considered to be moderate and erodibility is high. The estimated acreage is 259,441 for the association.

Wibaux Association (No. 7)

This unit is dominantly shallow but includes very shallow to moderately deep, well-drained sandy loam, clay loam, and channery loam soils on sloping to steep uplands and rough, broken land with shallow, sandy to medium-textured soils. This association occupies rolling to steep topography. It is characterized by numerous outcrops of scoria and scoria chips in the profile. Thirty to 60% of the surface has large scoria clinkers. These soils are highly erodible, and the productivity potential is low. The estimated acreage of this association is 220,274.

Renohill-Wibaux-Tassel-Shingle-Rockland Association (No. 8)

This unit includes shallow and moderately deep, well-drained sandy loam, clay loam, clay, and channery loam soils on sloping to steep uplands and rough, broken land with shallow, sandy to medium-textured soils.

The Renohill soils are moderately deep, fine textured, and occur on ridgetops and ridgecrests; Wibaux soils are shallow, well drained, medium textured, and gravelly, occurring on sloping to steep uplands; and Tassel and Shingle soils are shallow, sandy soils on rolling to steeply rolling slopes. Rockland within the unit consists of miscellaneous soil materials that are sandy to clayey on steep, broken slopes with exposed bedrock.

These soils are moderately to highly erodible with productivity potentials low to moderate. Acreage estimated for this association is 145,124.

Renohill-Cushman Association (No. 9)

This unit includes moderately deep, well-drained loam and clay loam soils on nearly level to moderately steep uplands. The Cushman soils are moderately deep soils on nearly level to gently sloping upland plains, while Renohill soils are situated on ridges and side slopes. Productivity potential and erodibility are considered moderate. The estimated acreage of the association is 275,548.

Renohill-Shingle-Terry Association (No. 10)

This association occupies the steep to very steep upland ridges and sidehills which are usually dissected with numerous drainages. The Renohill soils are moderately deep and fine textured and occur on ridgetops and ridgecrests. The Shingle and Terry soils are shallow and moderately deep, medium-textured to moderately coarse-textured soils of steeply sloping sidehills. Productivity potential is low and erodibility is high. The estimated acreage of this association is 148,224.

Renohill-Briggsdale-Ulm Association (No. 11)

This unit is represented by deep and moderately deep, well-drained loam, clay, and clay-loam soils on nearly level to sloping alluvial fans and nearly level to moderately steep uplands.

The Briggsdale and Renohill soils occur on nearly level to moderately steep uplands underlain by soft shale at depths of about 20 inches. The Ulm soils are situated on nearly level upland fans and terraces which are subject to short periods of overflow in the spring and summer. These soils have fine-textured subsoils which exhibit moderate to high shrink-swell potentials. The productivity potential and erodibility of these units are considered moderate. The acreage estimate of the association is 591,737.

Terry Association (No. 12)

This unit is dominantly moderately deep but includes deep to shallow, well to excessively drained, loamy fine sand, sandy loam, and fine, sandy loam soils on nearly level to moderately steep uplands underlain with sandstone. These soils are moderately to highly erodible and have low productivity potentials. The acreage estimate for this association is 37,239.

Shingle-Kim-Shale Rock Outcrops Association (No. 13)

This unit consists of a narrow band of rolling, gullied uplands on shale-sandstone foothills and stream terraces. Shingle soils are shallow and located on the steeper slopes. Kim soils are on alluvial fans. Vegetative production is poor. A moderate to severe erosion hazard exists. The estimated acreage of the association is 240,425.

Renohill-Ulm-Olney-Arvada-Bone Association (No. 14)

This unit consists of deep and moderately deep, medium to fine-textured soils on level to gentle slopes developed in alluvium, derived from shales, sandstone, and alkaline shales. Renohill soils are fine textured and underlain by soft shale at a depth of 20 to 40 inches. Ulm soils are fine textured and underlain by soft shale below 40 inches in depth. Olney soils are medium textured and underlain by sandstone at depths below 40 inches. Arvada and Bone soils are deep, strongly saline, impervious to water, and occur as alkali panspots. The productivity potential is low and erodibility is high. The estimated acreage is 171,557.

Renohill-Pugsley-Briggsdale Association (No. 15)

This unit includes moderately deep, nearly level to steep soils on uplands, upland ridges, ridgecrests, and sidehill slopes. The Renohill and Briggsdale are derived from shale; Pugsley soils form from sandstone. These soils are highly erodible and have low to moderate productivity potentials. The estimated acreage of the association is 70,246.

Renohill-Briggsdale-Ulm-Tassel-Rock Outcrop Association (No. 16)

This unit includes shallow, moderately deep and deep silty clays, loams, clay loams, and sandy loams on gently sloping to very steep slopes and rock outcrops.

The Renohill, Briggsdale, and Tassel soils are situated on moderately steep to steep uplands. Ulm soils are found on nearly level to sloping alluvial fans. The Briggsdale and Ulm soils exhibit moderate to high shrink-swell potentials. The Ulm soils are subject to short periods of overflow. The productivity potential is low to moderate and erodibility is high. This association contains an estimated 138,538 acres.

Shingle-Tassel-Dwyer-Olney-Bowbac Association (No. 17)

This unit consists of shallow to deep, sandy to medium-textured soils on rolling to steeply rolling slopes, including upland ridges and sidehills dissected by numerous drainages.

The Shingle and Tassel soils are generally less than 20 inches deep over sandstone and shale bedrock. Olney soils are more than 40 inches deep to sandstone bedrock. Bowbac soils are 20 to 40 inches deep to bedrock. Hummocks and dune topography are associated with the deep, sandy Dwyer soils. This unit is subject to severe wind erosion hazards and is moderately erodible by water. The productivity potential is low to moderate. The acreage estimation for the association is 309,742.

Dwyer-Tassel-Terry Association (No. 18)

This unit consists of deep to shallow, sandy soils on rolling uplands dissected by drainages.

The Dwyer soils are loamy sands, deeper than 40 inches to bedrock. The Tassel soils are less than 20 inches deep to sandstone bedrock and have sandy loam textures. The Terry soils are 20 inches to 40 inches deep to bedrock and have sandy loam textures. This unit is subject to severe wind erosion and is moderately erodible by water. The productivity potential is low. The acreage estimate for this association is 74,712.

Rauzi-Renohill-Arvada Association (No. 19)

These are moderately deep and deep, fine loamy and fine soils on rolling, steep slopes over interbedded sandstone and shale.

This association of soils occurs on moderately sloping hills, ridges, and alluvial fans underlain by soft shale at shallow depths. The Rauzi soils are deep and medium textured, formed from sandstone and shale; Renohill soils are moderately deep and fine textured developing in shale; Arvada soils are deep and saline-alkali developing on alluvial deposits. The erosion hazard is severe and the productivity potential is low. The estimated acreage of this association is 307,800.

Tassel-Shingle-Terry-Olney-Bowbac Association (No. 20)

This unit consists of shallow, moderately deep and deep, moderately sandy and loamy soils developed from sandstone and shale and occupying rolling to steep topography with gentle to steep slopes dissected by many small drainages. The Tassel and Shingle soils are shallow and occur on the steeply sloping uplands. The Olney, Bowbac, and Terry soils occur on side and foot slopes. The productivity potential is moderate. These soils are subject to severe wind erosion and moderate water erosion. The estimated acreage of the association is 444,450.

Valent-Dwyer-Duneland Association (No. 21)

This association occurs on undulating to rolling, hummocky dune topography and is made up of deep aeolain sands and some active dunes. The soils are excessively drained, deep, loose sands. Wind erosion is severe and water erosion is moderate. Productivity potential is moderate. The estimated acreage of this association is 98,912.

WATER RESOURCES

Groundwater

The yield of water from a well is often expanded as the number of gallons per minute for each foot of drawdown in the well. A well that yields 10 gallons per minute for each foot of drawdown is said to have a specific capacity of 10. Specific capacity is greatly dependent upon the ease with which water will pass through the formation (transmissivity) and an estimate of well yield can be obtained from transmissivity. There are several "rules of thumb"for this calculation, one of which states that when transmissivity is reported in square feet per day (as it is in Table RB-2), the yield of the well in gallons per minute per foot of drawdown can be obtained by dividing the transmissivity value by 250. It is emphasized this is an estimate; in addition to being dependent on transmissivity, the specific capacity depends on other factors such as well construction and time of pumping.

TABLE RB-1

SOIL INTERPRETATIONS FOR REGIONAL SOIL ASSOCIATION MAP 4, APPENDIX A

Soil Series Assoc. Occurrence	Classification	Typical Text. of Surface Layer	Parent Material	Natural Soil Drainage Class	Depth of Rooting Zone (in)	Available Water Capacity (in)	Permeability Least Perm. Layer(in/hr)	Potential Frost Action	Shrink-Swell Potential	Hydro-logic Soil Group
Arvada 14, 19	Ustollic Natrargid fine, montmorillonitic, mesic	Fine sandy loam	Alluvium	Well drained	60"	5-6"	0.06"	Low	High	D
Bankard 1	Ustic Torrifluvent sandy, mixed calcareous mesic	Loamy fine sand	Sandy Alluvium	Somewhat excessively drained	60"	3-4"	6.0-20.0"	Moderate	Low	A
Bone 14	Ustic Torriorthent fine, montmorillontic, (calcareous) mesic	Loam	Alluvium	Moderately well drained	60"	4-5"	0.06"	Moderate to high	High	D
Bowbac 3,7, 17, 20	Ustollic Haplargids fine loamy, mixed mesic	Sandy Loam	Alluvial sediments from inter-bedded shale and sandstone	Well drained	30"	4-5"	0.6-2.0"	Moderate	Low to Moderate	B
Briggsdale 11, 15, 16	Ustollic Paleargid fine, montmorillonitic, mesic	Loam	Inter-bedded sandstone & shale	Well drained	30"	4-6"	0.2-0.6"	High	Moderate	C
Cushman 6, 9	Ustollic Haplargid fine-loamy, mixed mesic	Sandy loam	Inter-bedded shale & sandstone	Well drained	30"	5-7"	0.2-0.6"	Low	Moderate	C
Dwyer 17, 18, 21	Ustic Torripsamments mixed, mesic	Fine sand	Aeolian sand	Excessively drained	60"	3-4"	6.0-20.0"	Low	Low	A
Haverson 1	Ustic Torrifluvent fine-loamy mixed (calcareous) mesic	Loam	Strati-fied alluvium	Well drained	60"	6-10"	0.6-2.0"	Low	Low	B

TABLE RB-1
(cont'd)

SOIL INTERPRETATIONS FOR REGIONAL SOIL ASSOCIATION MAP 4, APPENDIX A

Soil Series Assoc. Occurrence	Classification	Typical Text. of Surface Layer	Parent Material	Natural Soil Drainage Class	Depth of Rooting Zone (in)	Available Water Capacity (in)	Permeability Least Perm. Layer(in/hr)	Potential Frost Action	Shrink-Swell Potential	Hydro-logic Soil Group
Kim 1, 13	Ustic Torriorthent fine-loamy, mixed (calcareous) mesic	Loam	Alluvium	Well drained	60"	10-12"	0.6-2.0"	Low	Low	B
Maysdorf 3	Ustollic Haplargid fine-loamy, mixed	Sandy Loam	Alluvial	Well drained	60"	7-9"	0.6-2.0"	Moderate	Low to	B
Olney 3, 7, 14, 17, 20	Ustollic Haplargids fine-loamy, mixed mesic	Sandy Loam	Alluvial sediments from inter-bedded shale and sandstone	Well drained	60"	6-9"	0.6-2.0"	High	Low to moderate	B
Pugsley 15	Ustollic Haplargid, fine-loamy, mixed mesic	Sandy Loam	Sandstone	Well drained	24"	2-4"	2.0-6.0"	Moderate	Low to moderate	B
Rauzi 19	Ustollic Haplargid, fine-loamy mixed mesic	Sandy Loam	Alluvial sediments from inter-bedded shale and sandstone	Well drained	60"	7-9"	0.6-2.0"	Moderate	Low to moderate	B
Razor 2	Ustollic Camborthid, fine, montmorillonitic, mesic	Silty clay loam	Shale	Well drained	24"	3-4"	.06-0.2"	Moderate	High	C
Renohill 3, 5, 6, 7, 8, 9, 10, 11, 15, 16, 19	Ustollic Haplargids fine montmorillonitic mesic	Clay Loam	Shale	Well drained	30"	5-6"	0.06-0.2"	High	High	C

TABLE RB-1
(cont'd)

SOIL INTERPRETATIONS FOR REGIONAL SOIL ASSOCIATION MAP 4, APPENDIX A

Soil Series Assoc. Occurrence	Classification	Typical Text. of Surface Layer	Parent Material	Natural Soil Drainage Class	Depth of Rooting Zone (in)	Available Water Capacity (in)	Permeability Least Perm. Layer(in/hr)	Potential Frost Action	Shrink-Swell Potential	Hydro-logic Soil Group
Samsil 2, 3, 5, 7, 8, 10, 13, 14, 17, 20	Ustic Torriorthents clayey, mixed, calcareous, mesic, thin	Clay	Shale	Well drained	14"	2-3"	0.06-0.2"	High	High	C
Shingle 2, 3, 5, 7, 8, 10, 13, 17, 20	Ustic Torriorthents loamy, mixed (calcareous) mesic, shallow	Clay Loam	Inter-bedded sandstone, shale and loamstone	Well drained	15"	2-3"	0.2-0.6"	Low	Moderate	C
Tassel 8, 16, 17, 18, 20	Ustic Torriorthents loamy, mixed (calcareous) mesic, shallow	Fine sandy loam	Soft sandstone	Well drained	15"	1-2"	2.0-6.0"	Low	Low	D
Terry 5, 10, 12, 18, 20	Ustollic Haplargid coarse-loamy, mixed, mesic	Fine sandy loam	Soft sandstone	Well drained	36"	4-5"	2.0-6.0"	Moderate	Low	C
Ulm 3, 11, 14, 16	Ustollic Haplargids fine, montmorillonitic, mesic	Loam	Inter-bedded shale & sandstone	Well drained	60"	10-12"	0.6-2.0"	High	Moderate to high	B
Valent 21	Ustic Torripsamments mixed, mesic	Loamy sand	Aeolian sand	Excessively drained	60"	3-5"	6.0-20.0"	Low	Low	A
Wibaux 7, 8	Ustic Torriorthent loamy-skeletal over gragmental, mixed, nonacid, mesic	Channery loam	Channery material over scoria beds	Well to what excessively drained	15"	2-3"	0.6-2.0"	Low	Low	D
Wyarno 6	Ustollic Haplargid, fine, montmorillonitic, mesic	Clay Loam	Alluvium from shales	Well drained	60"	10-12"	0.2-0.6"	Moderate	High	B

TABLE RB-1
(cont'd)

SOIL INTERPRETATIONS FOR REGIONAL SOIL ASSOCIATION MAP 4, APPENDIX A

Soil Series / Assoc. Occurrence	Erodi-bility	Inherent Fertility	Potential* Production (#/ac. dry wt)	Land Capa-bility Classifi-cation	Range Site	Degrees of Limitation for and Soil Features Affecting: Final Cover for Mined Land — Inches Available	Final Cover for Mined Land — Suitability	Transpor-tation Routes	Depth of Surface Layer (inches)	Soil Reaction (pH)	Salinity (mmhos/cm)
Arvada 14, 19	Very High	Low	1400-2200	VIs	Saline Lowland	60"	Poor, clay content alkali	Severe, high shrink-swell low strength	3-6"	7.4- 9.0	2-8
Bankard 1	Very High wind erosion	Low	2000-3000	IVe	Lowland	60"	Poor, sandy	Moderate, occasional flooding, moderate frost action	3-8"	7.9-8.4	2-8
Bone 14	Very High	Low	1400-2200	VIIs	Saline Lowland	60"	Poor, high clay content alkali	Severe, clay texture, high shrink-swell	1"	9.2-9.6	2-8
Bowbac 3, 7, 17, 20	High Wind erosion	Medium	1000-2100	VIe	Sandy	30"	Fair, sandy loam	Moderate, bedrock at 20-40"	2-4"	7.0-8.4	2
Briggsdale 11, 15 16	High	Medium	850-2000	IVe	Loamy	36"	Poor-clay content	Severe, high frost action texture, plastic	3-8"	6.6-8.8	2
Cushman 6, 9	High	Medium	850-2000	VIe	Loamy	26"	Fair to good	Moderate low strength	1-3"	7.9-8.4	0-4
Dwyer 17, 18 21	Very high wind erosion	Low	1000-2100	VIe	Sandy	60"	Poor-sandy	Slight-slopes 8%, Moderate 8-15% slopes	4-8"	7.9-8.4	0-4

TABLE RB-1
(cont'd)

SOIL INTERPRETATIONS FOR REGIONAL SOIL ASSOCIATION MAP 4, APPENDIX A

Soil Series Assoc. Occurrence	Erodibility	Inherent Fertility	Potential* Production (#/ac. dry wt)	Land Capability Classification	Range Site	Final Cover for Mined Land: Inches Available	Final Cover for Mined Land: Suitability	Transportation Routes	Depth of Surface Layer (inches)	Soil Reaction (pH)	Salinity (mmhos/cm)
	Degrees of Limitation for and Soil Features Affecting										
Haverson 1	High wind if cultivated Low water erosion	Medium	2000-3000	IVe	Lowland	60"	Fair to Good	Moderate flooding low strength	3-6"	7.9-8.4	0-4
Kim 1, 13	High	Medium	850-2000	IVe	Loamy	60"	Fair to Good	Moderate, 8%, severe, slopes 8%	6-9"	7.9-8.4	0-4
Maysdorf 3	Medium	Medium	1000-2100	VIe	Sandy	50"	Fair to Good	Moderate, moderate frost action	4-6"	6.6-8.4	<2
Olney 3, 7, 14, 17, 20	Medium	Medium to high	1000-2100	VIe	Sandy	50"	Fair to Good	Severe, frost action	2-4"	7.0-8.4	2-4
Pugsley 15	Medium	Medium	1000-2100	VIe	Sandy	24"	Fair	Moderate, bedrock at 20-40"	2-4"	6.6-7.3	<2
Rauzi 19	Medium	Medium	1000-2100	VIe	Sandy	60"	Fair	Moderate frost action	4-6"	6.6-7.0	<2
Razor 2	High	Low	750-1800	IVe	Clayey	30"	Poor, clay content	Severe, high shrink-swell potential	2-4"	8.2-8.6	2-4

TABLE RB-1
(cont'd)

SOIL INTERPRETATIONS FOR REGIONAL SOIL ASSOCIATION MAP 4, APPENDIX A

Soil Series Assoc. Occurrence	Erodi-bility	Inherent Fertility	Potential* Production (#/ac. dry wt)	Land Capa-bility Classifi-cation	Range Site	Final Cover for Mined Land: Inches Available	Final Cover for Mined Land: Suitability	Transpor-tation Routes	Depth of Surface Layer (inches)	Soil Reaction (pH)	Salinity (mmhos/cm)
Renohill 3, 5, 6, 7, 8, 9, 10, 11, 15, 16, 19	High	Medium	750-1800	VIe	Clayey	25"	Poor, clay content	Severe, high shrink-swell potential	3-6"	7.0-8.6	<2
Samsil 2, 3, 5, 7, 8, 10, 13, 14, 17, 20	Very High	Medium	600-1100	VIIe	Shallow clayey	14"	Poor clayey shallow to bedrock	Severe, high shrink-swell potential	3-6"	7.4-9.0	0-4
Shingle 2, 3, 5, 7, 8, 10, 13, 17, 20	Very High	Low	450-1200	VIIe	Shallow loamy	18"	Poor, shallow depth to bedrock	Severe 4-15% slopes, low strength, Severe, 15-50% slopes, low strength and slope	3-6"	7.9-9.0	0-4
Tassel 8, 16, 17, 18, 20	Very high erosion	Low	600-1400	VIIe	Shallow sandy	18"	Poor sandy, shallow depth to bedrock	Severe, Bedrock at 10-20 inches	3-9"	7.9-8.4	0-4
Terry 5, 10, 12, 18, 20	High wind erosion	Low	1000-2100	VIe	Sandy	26"	Fair	Moderate, bedrock at 20-40"	4-6"	6.8-8.6	<2

TABLE RB-1
(cont'd)

SOIL INTERPRETATIONS FOR REGIONAL SOIL ASSOCIATION MAP 4, APPENDIX A

Soil Series Assoc. Occurrence	Erodi-bility	Inherent Fertility	Potential* Production (#/ac. dry wt)	Degrees of Limitation for and Soil Features Affecting Land Capa-bility Classifi-cation	Range Site	Final Cover for Mined Land Inches Available	Final Cover for Mined Land Suitability	Transpor-tation Routes	Depth of Surface Layer (inches)	Soil Reaction (pH)	Salinity (mmhos/cm)
Ulm 3, 11, 14, 16	High	Medium	850-2000	IVe	Loamy	60"	Poor clay content	Severe, high frost action potential	3-6"	6.6-8.6	2
Valent 21	Very high wind erosion	Low	1000-2100	VIe	Sandy	60"	Poor	Slight- 8% slopes Moderate- 8-15% slopes Severe- 15% slopes	3-5"	7.9-8.4	0-4
Wibaux 7, 8	High	Low	450-1200	VIIs	Shallow loamy	15"	Poor, very gravelly	Severe, bedrock at 10-20" steep slopes	2-4"	7.8-8.6	<2
Wyarno 6	Medium	Medium	750-1800	IVs	Clayey	60"	Poor, clay content	Severe, high shrink-swell potential	3-7"	6.8-8.6	<2

Table RB-1
(cont'd)

SOIL INTERPRETATIONS FOR REGIONAL SOIL ASSOCIATION MAP 4, APPENDIX A

*Low figure for unfavorable years, high figure for favorable years, normal years are average of high and low. Definitions applicable to the columns of the Soil Interpretations for Regional Soil Association Map.

Soil Series name and the distribution of the soil series within the different soil associations of the Powder River Basin study area.

Classification given is according to Soil Taxonomy for each series.

Typical texture of the surface refers to the relative proportions of the various size groups of individual soil grain, i.e. sands, silt, and clay.

Parent Material is the assumed geologic material the soil developed from.

Natural Soil Drainage Class is an expression of surface soil moisture relationships.

Depth of Rooting Zone is an indicator of the thickness plant roots can penetrate.

Available Water Capacity refers to the potential amount of water a soil can hold for plant use.

Permeability least Permeable layer is the rate at which water and air may move through the soil.

Potential Frost Action refers to the probable effects on structures results from the freezing of soil material.

Shrink-Swell Potential refers to the quality of a soil that determines its volume change resulting from wetting and drying.

Hydrologic Soil Groups are ranking of soils from A to D referring to runoff potential ranging from A, having the lowest rates to D with the highest rates.

Erodibility Class - The susceptibility of a soil to erosion when no cover is present. Rate of soil displacement is influenced primarily by soil qualities, physical properties, rainfall intensity, and slope gradient. Considered was each of six items listed within each of the three classes when classifying the area. Classes and rating items are as follows:

Class

Low - Potential erosion is not significant to reduce productivity.
- They contain water stable aggregates.
- They have good infiltration and percolation rates.
- They have adequate depth to store most of the normal precipitation.
- They contain no restrictive layers.
- They occur on gentle slopes.

Medium - Potential erosion is significant to reduce productivity but not to the point of entirely restricting production.
- They contain aggregates that are not water stable.
- They have moderate infiltration and percolation rates.
- They have moderate depths to store only part of the normal precipitation (AWC).
- They may contain restrictive layers.
- They occur on moderate slopes.

TABLE RB-1
(cont'd)

SOIL INTERPRETATIONS FOR REGIONAL SOIL ASSOCIATION MAP 4, APPENDIX A

High
- Potential erosion will cause a reduction in productivity to practically zero.
- They contain very unstable aggregates.
- They have slow infiltration and percolation rates.
- They have little soil for water storage.
- They contain restrictive layers.
- They occur on steep slopes.

Where wind erosion is a hazard, it is mentioned specifically.

Inherent fertility - the following criteria were used for rating the soils:

Low — Soils low in available P or K, or with pH below 5.0 in the A and upper B horizons, or soils having levels of alkalinity or salinity such that choice of plants or growth of plants is severly limited.

Medium — Soils intermediate between low and high in inherent fertility.

High — Soils high in available P and K, with pH of 5.5 or more in A and upper B horizons, levels of salinity or alkalinity are sufficiently low that choices or growth of plants are not limited.

The degrees of limitation for <u>Irrigation</u>, <u>Dwelling</u>, and <u>Transportation Routes</u> are listed as slight, moderate or severe and give restrictive features if degree of limitation is other than slight. The definition of limitations are listed below.

Definition of Limitations

<u>Slight</u> soil limitation is the rating given soils that have properties favorable for the rated use. The degree of limitation is minor and can be overcome easily. Good performance and low maintenance can be expected.

<u>Moderate</u> soil limitation is the rating given soils that have properties moderately favorable for the rated use. This degree of limitation can be overcome or modified by special planning, design or maintenance. Some soils rated <u>moderate</u> require treatment such as artificial drainages, runoff control to reduce erosion, extended sewage absorption fields, extra excavation or some modification of certain features through manipulation of the soil.

<u>Severe</u> soil limitation is the rating given soils that have one or more properties unfavorable for the rated use such as steep slopes, bedrock near the surface, high shrink-swell potential, a seasonal high water table, flooding hazard or low bearing strength. This degree of limitation generally requires major soil reclamation, special design or intensive maintenance. Some of these soils, however, can be improved by reducing or removing the soil feature that limits use, but in most situations, it is difficult and costly to alter the soil or to design a structure so as to compensate for a severe degree of limitation.

<u>Depth of surface layer (inches)</u> refers to depth of darker colored A horizon in inches.

<u>Soil reaction (pH)</u> The degree of acidity or alkalinity of a soil expressed as a pH value. Descriptive terms commonly associated with certain ranges in pH are: slightly acid, 6.1-6.5; neutral, 6.6-7.3; slightly alkaline, 7.4-7.8; moderately alkaline 7.9-8.4; strongly alkaline, 8.5-9.0; and very strongly alkaline, 9.1.

<u>Salinity (mmhos/cm)</u> refers to the soluble salts in a soil, based on the electrical conductivity of the saturation extract, as expressed in millimhos per centimeter (mmhos/cm) at 25C.

Salinity Rating	mmhos/cm
Low	4
Moderate	4-8
High	8

TABLE RB-2

AQUIFER TESTS IN THE FOX HILLS SANDSTONE, THE LANCE, FORT UNION, AND WASATCH FORMATIONS, AND THE ALLUVIUM IN THE POWDER RIVER BASIN OF WYOMING

CAMPBELL COUNTY

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Fox Hills--Lance						
50-69-18 NE SW	Rozet #5	46	-	-	Sandstone	Company
Fort Union						
45-70-04 NW NW NW	CCR-3	32.08	-	-	Coal	Company
45-70-04 NW SE SE	CCR-2	1.34	-	-	Coal	Company
45-70-04 NW SE SE	CCR-2a	5.35	-	-	Coal	Company
46-70-18 NE NE NE	CCR-27	51.87	-	.000125	Coal	Company
46-70-18 NE NE NE	CCR-27a	61.76	-	-	Coal	Company
46-70-18 SW SW NE	CCR-24	343.58	-	-	Coal	Company
46-70-18 SE SE SE	CCR-21	401.07	-	-	Coal	Company
46-70-19 SW SW NE	CCR-17	1,470.59	-	-	Coal	Company
46-70-19 SW SW NE	CCR-17a	1,470.59	-	.000567	Coal	Company
46-70-19 SE SE SE	CCR-14	116.98	-	-	Coal	Company
46-70-19 SE SE SE	CCR-14a	110.29	-	.00050	Coal	Company

TABLE RB-2
(cont'd)

AQUIFER TESTS IN THE FOX HILLS SANDSTONE, THE LANCE, FORT UNION, AND WASATCH FORMATIONS, AND THE ALLUVIUM IN THE POWDER RIVER BASIN OF WYOMING
CAMPBELL COUNTY (cont'd)

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Fort Union (cont'd)						
46-70-19 SE SE SE	CCR-14c	155.75	-	.00146	Coal	Company
46-70-20 NE NE SW	CCR-18	22.73	-	-	Coal	Company
46-70-20 SW SW SW	CCR-14b	80.21	-	.00056	Coal	Company
46-70-27 SE SE NW	CCR-13	213.90	-	-	Coal	Company
46-70-28 NE NE NE	CCR-16	25.40	-	-	Coal	Company
46-70-29 NE NE SW	CCR-11	12.03	-	-	Coal	Company
46-70-29 SW SW SW	CCR-8	802.14	-	.000346	Coal	Company
46-70-29 SW SW SW	CCR-8a	815.51	-	-	Coal	Company
46-70-29 SE SE SE	CCR-9	110.29	-	-	Coal	Company
46-70-32 NW NW SE	CCR-5	306.15	-	-	Coal	Company
46-70-32 NW NW SE	CCR-5a	447.86	-	.000161	Coal	Company
46-70-33 SW SW NE	CCR-6	.40	-	-	Coal	Company
46-70-34 NW NW NW	CCR-10	362.30	-	-	Coal	Company
46-70-34 NE NE SW	CCR-7a	10,026.74	-	-	Coal	Company

TABLE RB-2
(cont'd)

AQUIFER TESTS IN THE FOX HILLS SANDSTONE, THE LANCE, FORT UNION, AND WASATCH FORMATIONS, AND THE ALLUVIUM IN THE POWDER RIVER BASIN OF WYOMING
CAMPBELL COUNTY (cont'd)

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Fort Union (cont'd)						
46-70-34 SW SW SW	CC-4a	11.76	-	-	-	Company
47-71-04 SW SE SE	-	526.74	8.9	-	Coal	Company
48-71	-	295.72	-	-	Coal	Company
48-71-27 NW NW SE	WRRI-7	295.86	-	.0834	-	Company
50-71	EG40C-8	22.06	1.11	.0002	Coal	Company
50-71-05 SE SE NW	EG1-2	26.74	1.74	.35	Coal	Company
50-71-05 SE SE NW	EG6-AC	1.74	.016	.0014	Coal	Company
50-71-05 SE SE NW	EG6B	8.42	.08	.0012	Coal	Company
50-71-06 NE SW NW	EG4	14.17	.71	.000001	Coal	Company
50-71-06 SW SW SW	EG5C	1.60	.08	.00001	Coal	Company
50-71-17 NE NW NE	EG3-3	48.26	.48	.00078	Coal	Company
50-71-17 SE SE NW	EG9C	.67	.03	.00010	Coal	Company
50-71-17 SW SE SE	EG3-4	52.41	.52	.0012	Coal	Company

TABLE RB-2
(cont'd)

AQUIFER TESTS IN THE FOX HILLS SANDSTONE, THE LANCE, FORT UNION, AND WASATCH FORMATIONS,
AND THE ALLUVIUM IN THE POWDER RIVER BASIN OF WYOMING
CAMPBELL COUNTY (cont'd)

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Fort Union (cont'd)						
50-71-21 NE SW SE	EG17C	9.89	.49	.01	Coal	Company
50-71-22 NE SW	Wyodak #7	108.29	3.88	.00009	Sandstone	USGS
50-71-27 NE NE NW	Wyodak #5	160.43	1.74	.00010	Sandstone	USGS
50-71-27 NW SW NW	Wyodak #6	128.34	1.87	.000075	Sandstone	USGS
50-71-29 SE NE	EG16AF	49.60	2.54	.00001	Sandstone	Company
50-71-29 SE NE	EG16AC	1,167	12.43	.33	Coal	Company
50-71-29 SE NE	EG16B	189.84	1.87	.0058	Coal	Company
50-71-29 SE NE	EG16C	189.84	1.87	.0058	Coal	Company
50-71-29 SW SE SW	EG18C	.13	.007	.001	Coal	Company
51-72-11 SW	-	15.37	-	.00020	Coal	Company
51-72-11 SW	-	41.44	-	.0030	Coal	Company
51-72-27	D305A	187.16	-	.00016	Coal	Company
52-72-32 SE NE	P-27	668.45	6.31	.00073	Coal	Company

TABLE RB-2
(cont'd)

AQUIFER TESTS IN THE FOX HILLS SANDSTONE, THE LANCE, FORT UNION, AND WASATCH FORMATIONS, AND THE ALLUVIUM IN THE POWDER RIVER BASIN OF WYOMING
CAMPBELL COUNTY (cont'd)

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Fort Union (cont'd)						
52-72-32 SE NE	P-27	1,229.95	11.60	.00049	Coal	Company
52-72-32 SE SW	CT-1	-	-	-	Coal	Company
52-72-32 SE SW	P-17	582.89	4.66	.00049	Coal	Company
52-72-32 SE SW	P-18	582.89	4.32	.0011	Coal	Company
52-72-32 SE SW	P-19	582.89	4.48	.0011	Coal	Company
Fort Union--Wasatch						
52-72-32 SE NE	CT-2	668.45	4.68	-	Sandstone and coal	Company
52-72-32 SE NE	P-26	855.61	5.82	.00073	Sandstone and coal	Company
52-72-32 SE NE	P-26	895.72	6.10	.00048	Sandstone and coal	Company
52-72-32 SE NE	P-29	788.77	5.63	.00047	Sandstone and coal	Company
52-72-32 SE NE	P-29	895.72	6.40	.00038	Sandstone and coal	Company

TABLE RB-2
(cont'd)

AQUIFER TESTS IN THE FOX HILLS SANDSTONE, THE LANCE, FORT UNION, AND WASATCH FORMATIONS, AND THE ALLUVIUM IN THE POWDER RIVER BASIN OF WYOMING
CAMPBELL COUNTY (cont'd)

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Fort Union--Wasatch (cont'd)						
52-72-32 SE NE	P-30	868.98	5.08	.00089	Sandstone and coal	Company
52-72-32 SE NE	P-30	895.72	5.24	.00085	Sandstone and coal	Company
Wasatch						
47-71-04 SW SE SE	-	53.48	.54	-	-	USGS
47-72-07	-	-	-	-	Coal	USGS
48-71-05 SE SE SE	Belle Ayr N-5	868.98	-	.00010	Sandstone	Company
50-71-29 SW SE SW	EG18W	5.08	.25	.003	Shale	Company
50-72-35 SE SE	-	91.84	-	-	Sandstone	Company
52-72-32 SE NE	P-28	962.57	19.25	.00073	Sandstone	Company
52-72-32 SE NE	P-28	1,229.95	24.60	.00058	Sandstone	Company
Alluvium						
51-72-05 NE NW	OT-2B	449.20	22.46	-	-	Company
51-72-05 NE NW	P-24	1,203.21	52.27	.060	-	Company
51-72-05 NE NW	P-25	1,336.90	66.84	.035	-	Company

TABLE RB-2
(cont'd)

AQUIFER TESTS IN THE FOX HILLS SANDSTONE, THE LANCE, FORT UNION, AND WASATCH FORMATIONS, AND THE ALLUVIUM IN THE POWDER RIVER BASIN OF WYOMING
CROOK COUNTY

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Lance						
49-68-36 NW SE	-	22.73	.80	-	-	USGS
50-68-14 SE SW	-	141.7	3.48	-	-	USGS
50-68-24 SE SW	-	280.75	4.68	-	-	USGS
Fort Union						
49-68-16 NE SW	-	57.49	.69	-	-	USGS
49-68-27 SW NW	-	8.02	.07	-	-	USGS
49-68-28 NW NE	-	21.39	.80	-	-	USGS
49-68-29 SW NW	-	4.01	.07	-	-	USGS
Alluvium						
50-67-04 SW SW	-	1,470.59	77.54	-	-	USGS
50-67-05 SW SE	-	45.45	1.87	-	-	USGS
54-65-13 NE NW	-	2,754.0	81.55	-	-	USGS
55-64-32 NW SW	-	28.07	6.95	-	-	USGS

TABLE RB-2
(cont'd)

AQUIFER TESTS IN THE FOX HILLS SANDSTONE, THE LANCE, FORT UNION, AND WASATCH FORMATIONS, AND THE ALLUVIUM IN THE POWDER RIVER BASIN OF WYOMING

JOHNSON COUNTY

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Wasatch						
51-82-33 SE SE	-	334.22	2.27	-	-	USGS

NATRONA COUNTY

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Fox Hills						
40-78-15 NW NE	-	213.90	-	.37	Sandstone	Wyoming State

NIOBRARA COUNTY

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Alluvium						
38-63-30 SE SW	-	4,411.76	-	-	-	USGS

TABLE RB-2
(cont'd)

AQUIFER TESTS IN THE FOX HILLS SANDSTONE, THE LANCE, FORT UNION, AND WASATCH FORMATIONS, AND THE ALLUVIUM IN THE POWDER RIVER BASIN OF WYOMING
SHERIDAN COUNTY

Location (Township, Range, Section)	Owner Number	Transmissivity (ft^2/day)	Conductivity (Permeability) (ft/day)	Storage	Lithology	Source of Data
Fort Union						
54-84-05 NE SE	-	12.70	1.06	.00035	Sandstone	USGS
55-84-27 SW NW	-	1.34	.33	.000090	Sandstone	USGS
Wasatch						
54-81-14 SW NW	-	69.52	.87	.024	Coal	USGS
57-83-14 NE NW	-	294.11	-	-	Sandstone	USGS
Alluvium						
56-82-34 SW SE	-	1,297.0	51.0	-	-	USGS
57-85-19 NW NE	-	2,714.0	147.0	-	-	USGS
Spoil						
57-84-22 SE SW	-	22.99	.53	.233	-	SDSM*
57-85-01 NW SE	-	1,103.88	60.16	.128	-	SDSM

* South Dakota School of Mines (Rahn 1977)

TABLE RB-3

TYPICAL CLASSES OF ORGANIC COMPOUNDS
FOUND IN THE MAJOR AND MINOR FRACTIONS

Major/Minor Fractions	Hydrophobic	Hydrophillic
Acid	Aliphatic acids <5 carbons, aromatic acids, and high molecular weight phenols.	Polyfunctional acids, carboxylic and dicarboxylic acids, and hydroxy acids.
Basic	Aromatic bases.	Polyfunctional aliphatic bases.
Neutral	High molecular weight hydrocarbons, polynuclear aromatics, and high molecular weight alcohols, aldehydes, ketones, amides, and nitriles.	Polyfunctional and lower molecular weight alcohols, aldehydes, ketones, amides, and nitriles.

Source: Reports of Geological Survey

TABLE RB-4

DISSOLVED ORGANIC CARBON FRACTIONS FOUND IN WATER
IN CAMPBELL COUNTY, WYOMING
Results in mg/l

HYDROPHOBIC

Station Number	Acid	Base	Neutral
1	1.3	<0.1	0.3
2	1.5	<0.1	0.3
3	2.8	<0.1	0.8
4	2.6	<0.1	1.4

HYDROPHILLIC

Station Number	Acid	Base	Neutral
1	1.0	0.1	0.4
2	2.0	0.2	0.3
3	4.0	0.3	0.5
4	2.7	0.3	0.3

Source: Reports of Geological Survey

TABLE RB-5
STREAMFLOW CHARACTERISTICS AT GAGING STATIONS

Station Number* and Type	Station Name	Drainage Area (sq. mi.)	Records Available (years)	Annual Mean Discharge (cfs) Average	Annual Mean Discharge (cfs) Range	Range of Annual Minimum Daily Discharge (cfs)
06312910 S-R	Dead Horse Creek tributary near Midwest	1.53	1965-72	-	-	0-0
06312920 S-R	Dead Horse Creek tributary No. 2 near Midwest	1.34	1965-72	-	-	0-0
06313000 C	South Fork Powder River near Kaycee	1,150	1938-40, 1950-69	36.2	10.5-109	0-4.6
06313020 S-R	Bobcat Creek near Edgerton	8.29	1965-73	-	-	0-0
06313050 S-R	East Teapot Creek near Edgerton	5.44	1965-72	-	-	0-0
06313100 C-S	Coal Draw near Midwest	11.4	1961-	-	-	0-0
06313180 S-R	Dugout Creek tributary near Midwest	.71	1965-73	-	-	0-0
06313200 C-S	Hay Draw near Midwest	1.60	1958-70	-	-	0-0
06313700 C-S, C	Dead Horse Creek near Buffalo	155	C-S 1958-71, C 1971-	-	-	0-0
06316480 S-R	Headgate Draw at upper station near Buffalo	3.32	1965-73	-	-	0-0

TABLE RB-5
(cont'd)
STREAMFLOW CHARACTERISTICS AT GAGING STATIONS

Station Number* and Type	Station Name	Drainage Area (sq. mi.)	Records Available (years)	Annual Mean Discharge (cfs) Average	Annual Mean Discharge (cfs) Range	Range of Annual Minimum Daily Discharge (cfs)
06316700 S-R	Powder River tributary near Buffalo	1.64	1965-73	-	-	0-0
06317000 C	Powder River at Arvada	6,050	1930-33, 1934-	272	70.3-668	0-24
06317050 C-S	Spotted Horse Creek tributary near Spotted Horse	4.28	1961-	-	-	0-0
06324800 C-S	Little Powder River tributary near Gillette	.81	1960-	-	-	0-0
06324810 S-R	Box Draw tributary near Gillette	.5	1965-72	-	-	0-0
06324900 C-S	Little Powder River tributary No. 2 near Gillette	3.95	1959-	-	-	0-0
06325000 C	Little Powder River at Biddle, Montana	1,541	1938-43	-	20.5-30.2	0-0
06334000 C	Little Missouri River near Alzada	904	1911-25, 1928-32, 1935-69	77.2	1.92-324	0-.1
06363700 C-S	Porcupine Creek near Turnercrest	31.5	1959-	-	-	0-0
06378640 C-S	Lance Creek tributary near Lance Creek	1.2	1965-	-	-	0-0

TABLE RB-5
(cont'd)
STREAMFLOW CHARACTERISTICS AT GAGING STATIONS

Station Number* and Type	Station Name	Drainage Area (sq. mi.)	Records Available (years)	Annual Mean Discharge (cfs) Average	Annual Mean Discharge (cfs) Range	Range of Annual Minimum Daily Discharge (cfs)
06379600 C, C-S	Box Creek near Bill	112	C 1956-58, C-S 1959-	-	-	0-0
06382200 S-R	Pritchard Draw near Lance Creek	5.1	1965-	-	-	0-0
06386000 C	Lance Creek at Spencer	2,070	1948-54, 1956-	26.3	2.74-73.9	0-0
06386500 C	Cheyenne River near Spencer	5,270	1948-	59.4	5.95-283	0-0
06426000 C	Belle Fourche River near Moorcroft	1,380	1923-33	67.8	3.0-244	0-.3
06426200 C-S	Donkey Creek tributary near Gillette	.28	1960-	-	-	0-0
06426500 C	Belle Fourche River below Moorcroft	1,670	1924-70	21.0	1.14-104	0-0
06644840 S-R	McKenzie Draw tributary near Casper	2.02	1965-73	-	-	0-0
06648720 S-R	Frank Draw tributary near Orpha	.79	1965-73	-	-	0-0
06648780 S-R	Sage Creek tributary near Orpha	1.38	1965-73	-	-	0-0

TABLE RB-5
(cont'd)
STREAMFLOW CHARACTERISTICS AT CAGING STATIONS

Station Number* and Type	Station Name	PEAK FLOWS: Average Recurrence Interval (years) 2	5	10	25	50	Maximum Observed: Date	Oischarge (cfs)	Unit Discharge (cfs/sq mi)	Factors Affecting Natural Flow
06312910 S-R	Dead Horse Creek tributary near Midwest	388	1,130	2,170	-	-	6-20-69	3,020	2,000	
06312920 S-R	Dead Horse Creek tributary No. 2 near Midwest	226	550	922	-	-	6-4-72	1,470	1,100	
06313000 C	South Fork Powder River near Kaycee	2,630	8,150	14,900	28,600	43,800	5-22-62	35,500	30.9	
06313020 S-R	Bobcat Creek near Edgerton	24	260	850	-	-	9-11-73	1,070	129	
06313050 S-R	East Teapot Creek near Edgerton	320	1,300	2,700	-	-	6-10-65	4,450	818	
06313100 C-S	Coal Draw near Midwest	696	1,900	2,730	-	-	6-22-64	2,620	230	
06313180 S-R	Dugout Creek tributary near Midwest	251	635	1,050	-	-	7-15-67	1,590	2,239	
06313200 C-S	Hay Draw near Midwest	300	634	920	1,350	-	7-15-67	900	562	
06313700 C-S, C	Dead Horse Creek near Buffalo	822	1,560	2,040	2,600	-	5-26-62	2,300	14.8	
06316480 S-R	Headgate Draw at upper station near Buffalo	200	1,900	4,600	-	-	6-15-65	5,490	1,650	

TABLE RB-5
(cont'd)
STREAMFLOW CHARACTERISTICS AT GAGING STATIONS

Station Number* and Type	Station Name	PEAK FLOWS: Average Recurrence Interval (years) 2	5	10	25	50	Maximum Observed: Date	Discharge (cfs)	Unit Discharge (cfs/sq mi)	Factors Affecting Natural Flow
06316700 S-R	Powder River tributary near Buffalo	258	1,100	2,250	-	-	6-16-65	2,290	1,400	
06317000 C	Powder River at Arvada	7,330	14,700	22,200	36,000	50,500	9-29-23	100,000	16.5	Irrigation diversions, numerous reservoirs.
06317050 C-S	Spotted Horse Creek tributary near Spotted Horse	91	412	985	2,660	-	6-13-62	3,120	729	
06324800 C-S	Little Powder River tributary near Gillette	-	-	-	-	-	6-22-64	176	218	
06324810 S-R	Box Draw tributary near Gillette	10	60	150	-	-	5-22-68	84	168	
06324900 C-S	Little Powder River tributary No. 2 near Gillette	168	350	502	725	-	6-22-64	758	192	
06325000 C	Little Powder River at Biddle, Montana	0	0	0	0	0	8-17-40	5,700	3.70	Small diversions for irrigation of hay meadows above station
06334000 C	Little Missouri River near Alzada, Montana	1,940	3,350	4,220	5,210	5,860	4-4-44	6,000	6.64	Do.
06363700 C-S	Procupine Creek near Turnercrest	-	-	-	-	-	6-15-62	1,230	39.0	

TABLE RB-5
(cont'd)
STREAMFLOW CHARACTERISTICS AT GAGING STATIONS

Station Number* and Type	Station Name	PEAK FLOWS: Average Recurrence Interval (years) 2	5	10	25	50	Maximum Observed: Date	Discharge (cfs)	Unit Discharge (cfs/sq mi)	Factors Affecting Natural Flow
06378640 C-S	Lance Creek tributary near Lance Creek	60	331	744	-	-	9-3-68	1,060	883	
06379600 C, C-S	Box Creek near Bill	145	692	1,560	3,660	-	5-5-71	1,720	15.4	
06382200 S-R	Pritchard Draw near Lance Creek	763	2,140	3,420	-	-	9-3-68	4,050	794	
06386000 C	Lance Creek at Spencer	1,970	3,600	4,790	6,340	7,500	5-24-71	7,410	3.58	Numerous small reservoirs, diversions for irrigation of 3,500 acres.
06386500 C	Cheyenne River near Spencer	3,160	6,620	9,820	15,000	19,900	5-27-62	16,000	3.04	Numerous small reservoirs, diversions for irrigation of 6,860 acres.
06426000 C	Belle Fourche River near Moorcroft	2,000	7,000	11,000	-	-	4-7-24	12,500	9.06	Numerous small reaervoirs, diversions for irrigation.
06426200 C-S	Donkey Creek tributary near Gillette	34	57	84	137	-	7-22-66	165	589	
06426500 C	Belle Fourche River below Moorcroft	898	2,040	3,050	4,600	5,950	4-7-24	12,500	7.49	Numerous small reservoirs, diversions for irrigation.

TABLE RB-5
(cont'd)
STREAMFLOW CHARACTERISTICS AT GAGING STATIONS

Station Number* and Type	Station Name	PEAK FLOWS: Average Recurrence Interval (years) 2	5	10	25	50	Maximum Observed: Date	Discharge (cfs)	Unit Discharge (cfs/sq mi)	Factors Affecting Natural Flow
06644840 S-R	McKenzie Draw tributary near Casper	32	212	540	-	-	9- -73	970	480	
06648720 S-R	Frank Draw tributary near Orpha	50	212	408	-	-	8-19-66	342	433	
06648780 S-R	Sage Creek tributary near Orpha	22	94	181	-	-	7-25-65	229	166	

Source: Reports of the Geological Survey

* Refer to Figure R2-16.

C: continuous record gaging station.

C-S: partial-record gage for determining peak flows.

S-R: partial-record gage for determining rainfall-runoff relations.

TABLE RB-6
SUSPENDED SEDIMENT DATA

			Observed Daily Values					
Station Number*	Station Name	Period of Record	Date	Flow (cfs)	Maximum Concentration (mg/l)	Date	Flow (cfs)	Maximum Load (tons/day)
06313100	South Fork Powder River near Kaycee	1950-53	9/7/51	852	94,800	5/22/52	4,260	1,270,000
06313500	Powder River at Sussex	1950-53	8/3/53	1,090	87,500	5/23/52	14,100	2,850,000
06317000	Powder River at Arvada	1947-57 1968	7/19/54	792	113,000	5/24/52	12,500	2,340,000
06334000	Little Missouri River near Alzada, Montana	1949-52	5/21/49	57	20,300	5/10/50	1,180	17,600
06386000	Lance Creek near Spencer	1950-54, 1957-59	7/19/54	74	57,700	6/27/52	3,620	281,000
06394000	Beaver Creek near Newcastle	1949-57	5/22/57	134	36,000	5/25/57	780	90,800
06426500	Belle Fourche River below Moorcroft	1947-52	---	-	-	9/5/51	710	12,400

Source: Reports of the Geological Survey.

* Refer to Figure R2-16.

TABLE RB-7
CHEMICAL QUALITY OATA

Station Number	Station Name	Period of Record (month/year)	Oissolved Calcium (Ca) (mg/1) Max	Min	Oissolved Magnesium (Mg) (mg/1) Max	Min	Oissolved Sodium (Na) (mg/1) Max	Min	Oissolved Bicarbonate (HCO_3) (mg/1) Max	Min	Dissolved Sulfate (SO_4) (mg/1) Max	Min	Oissolved Solids (mg/1) Max	Min	Temperature (Oegrees C.) Max	Min
06313400	Salt Creek near Sussex, Wyoming (sampled about monthly)	10/67 to 09/75	582 0.1*	23 25*	179 9.0*	6.8 0.1*	2,000 12*	82 11*	1,410 12*	172 0.1*	1,900 26*	76 18*	5,660 26*	2,640 137*	31.0 16*	.0 9.1-46*
06324830	Rawhide Creek** at U.S. Highway 14/16 Wy. (3 samples)	03/75 to 08/76	400 -*	390 .18*	490 -*	470 .18*	685 -*	650 -*	638 -*	334 6.7*	4,000 9.6*	780 1.0*	5,890 .18*	1,410 6.7*	25.0 .18*	20.3 6.7*
06324890	Little Powder River** below Corral Creek, Wy. (3 samples)	06/75 to 11/76	420 9.6*	330 1.0*	190 9.6*	150 1.0*	150 9.6*	130 1.0*	296 9.6*	280 1.0*	1,900 9.6*	1,500 1.0*	2,890 9.6*	2,310 1.0*	24.0 .73*	4.0 1.0*
06324912	Little Powder River** above Cottonwood Creek, Wy (3 samples)	06/75 to 11/76	410*** 5.2*		190*** 5.2*		150*** 5.2*		297*** 5.2*		1,900*** 5.2*		2,800*** 5.2*		21.5 5.2*	5.5 -*
06324925	Little Powder River** near Weston,Wy. (1 sample)	06/75	190*** 2.1*		110*** 2.1*		340*** 2.1*		453*** 2.1*		1,200*** 2.1*		2,090*** 2.1*			18.0*** 2.1*
06324970	Little Powder River** above Dry Creek near Weston, Wy. (53 samples)	06/75 to 06/77	320 1.4*	46 16*	180 1.4*	23 16*	590 .31*	100 16*	633 6.0*	112 16*	2,100 .02*	340 5.4*	3,440 .02*	621 5.4*	27.0 .00	.0 .5-17*

TABLE RB-7
(cont'd)
CHEMICAL QUALITY DATA

Station Number	Station Name	Period of Record (month/year)	Dissolved Calcium (Ca) (mg/1) Max	Min	Dissolved Magnesium (Mg) (mg/1) Max	Min	Dissolved Sodium (Na) (mg/1) Max	Min	Dissolved Bicarbonate (HCO_3) (mg/1) Max	Min	Dissolved Sulfate (SO_4) (mg/1) Max	Min	Dissolved Solids (mg/1) Max	Min	Temperature (Degrees C.) Max	Min
06426500	Belle Fourche** River below Moorcroft, Wy. (sampled periodically)	08/54 to 09/57											2,910 0.3*	162 132*		
	(sampled monthly)	7-9/75	59 .05*	30 .10*	50 .10*	23 3.4*	580 .05*	100 3.4*	657 .05*	169 3.4*	1,000 .05*	260 3.4*	2,050 .05*	544 3.4*	31 .05*	27 .10

Source: Reports of the Geological Survey.

Note: Refer to Figure R2-16 for station locations.

* Streamflow discharge in cfs (cubic feet per second).
** Other analyses, trace metals, biological data, coliform, field tests of dissolved oxygen, and more are available in various reports of Geological Survey.
*** Only one value.

FISH AND WILDLIFE

REGIONAL BIRD SPECIES LIST
SUMMER 1978

Birds not checked below are species potentially occurring in the region.

Observed	Censused	Common Name
X		Horned grebe
X		Eared grebe
X		Pied-billed grebe
X		Canada goose
X		Mallard
		Gadwall
X		Pintail
		American green-winged teal
X	X	Blue-winged teal
X		Cinnamon teal
X		American wigeon
X		Shoveler
		Redhead
		Canvasback
X		Lesser scaup
		Common goldeneye
		Barrow's goldeneye
		White-winged scoter
		Ruddy duck
		Common merganser
		Red-breasted merganser
		Hooded merganser
X		Goshawk
		Sharp-shinned hawk
		Cooper's hawk
X	X	Red-tailed hawk
		Harlan's hawk
X	X	Swainson's hawk
X	X	Rough-legged hawk
X	X	Ferruginous hawk
X	X	Golden eagle
		Bald eagle
X	X	Marsh hawk
X	X	Prairie falcon
		Peregrine falcon
X		Merlin
X	X	American kestrel
X	X	Turkey
X		Sharp-tailed grouse
X	X	Sage grouse
X	X	Ring-necked pheasant
X		Gray partridge
X		Great blue heron
		Snowy egret
		Least bittern

Observed	Censused	Common Name
		American bittern
X		White-faced ibis
X		Sandhill crane
		Virginia rail
X		American coot
X	X	Killdeer
		Mountain plover
X	X	Common snipe
		Long-billed curlew
X		Upland plover
		Spotted sandpiper
		Willet
X		Greater yellowlegs
X		Lesser yellowlegs
		Long-billed dowitcher
		Semipalmated sandpiper
		Western sandpiper
X		American avocet
X	X	Wilson's phalarope
		California gull
		Ring-billed gull
		Franklin's gull
		Black tern
X		Rock dove
X	X	Mourning dove
		Yellow-billed cuckoo
X	X	Black-billed cuckoo
		Barn owl
X	X	Great horned owl
		Screech owl
X		Burrowing owl
		Barred owl
		Long-eared owl
		Short-eared owl
		Saw-whet owl
		Poor-will
X	X	Common nighthawk
		White-throated swift
		Broad-tailed hummingbird
		Belted kingfisher
X	X	Common flicker
X	X	Red-headed woodpecker
		Lewis' woodpecker
		Yellow-bellied sapsucker
X		Hairy woodpecker
		Downy woodpecker
X	X	Eastern kingbird
X	X	Western kingbird
		Great crested flycatcher
		Eastern phoebe
X	X	Say's phoebe
		Willow flycatcher
		Northern flycatcher
X	X	Dusky flycatcher
X	X	Gray flycatcher
X	X	Western flycatcher

Observed	Censused	Common Name
X	X	Western wood peewee
X	X	Horned lark
		Tree swallow
		Bank swallow
		Rough-winged swallow
X	X	Barn swallow
X	X	Cliff swallow
		Purple martin
X		Blue jay
		Pinon jay
X	X	Black-billed magpie
X	X	Common crow
X	X	Black-capped chickadee
		Mountain chickadee
X	X	White-breasted nuthatch
		Red-breasted nuthatch
		Brown creeper
X	X	House wren
		Long-billed marsh wren
		Canyon wren
X	X	Rock wren
		Catbird
X	X	Brown thrasher
X		Sage thrasher
X	X	Robin
		Hermit thrush
		Swainson's thrush
		Veery
		Eastern bluebird
X	X	Mountain bluebird
		Golden-crowned kinglet
		Ruby-crowned kinglet
		Sprague's pipit
		Bohaemian waxwing
		Cedar waxwing
		Northern shrike
X	X	Loggerhead shrike
X		Starling
		Solitary vireo
X	X	Red-eyed vireo
		Warbling vireo
		Black-and-white warbler
		Orange-crowned warbler
X	X	Yellow warbler
		Magnolia warbler
X	X	Yellow-rumped warbler
		Chestnut-sided warbler
		Blackpoll warbler
		Ovenbird
		Northern waterthrush
		Yellowthroat
X	X	Yellow-breasted chat
		Wilson's warbler
		American redstart
X		House sparrow
		Bobolink

Observed	Censused	Common Name
X	X	Western meadowlark
		Yellow-headed blackbird
X	X	Red-winged blackbird
X	X	Brewer's blackbird
X	X	Common grackle
		Brown-headed cowbird
X		Northern oriole
X	X	Northern oriole
X	X	Western tanager
X	X	Black-headed grosbeak
		Evening grosbeak
X		Lazuli bunting
X	X	Cassin's finch
		House finch
		Pine grosbeak
		Pine siskin
X	X	American goldfinch
X	X	Red crossbill
		Rufous-sided towhee
		Savannah sparrow
		Grasshopper sparrow
X	X	Lark bunting
X	X	Vesper sparrow
X	X	Lark sparrow
X	X	Sage sparrow
X	X	Dark-eyed junco (slate-colored junco)
		Tree sparrow
X	X	Chipping sparrow
		Clay-colored sparrow
X	X	Brewer's sparrow
		Harris' sparrow
		White-crowned sparrow
		White-throated sparrow
		Fox sparrow
		Lincoln's sparrow
X	X	Song sparrow
X	X	McCown's longspur
X	X	Chestnut-collared longspur
		Lapland longspur

REGIONAL MAMMAL SPECIES LIST

Mammals not checked below are species potentially occurring in the region.

Observed	Caught or Censused	Common Name
		Opossum
		Masked shrew
		Vagrant shrew
		Merriam's shrew
X		Little brown myotis
		Long-eared myotis
		Long-legged myotis
		Silver-haired bat
		Horay bat
		Townsend's bat
		Big brown bat
X	X	Nuttall's cottontail
X	X	Desert cottontail
X	X	White-tailed jackrabbit
X	X	Black-tailed jackrabbit
X	X	Least chipmunk
X	X	Thirteen-lined ground squirrel
X	X	Black-tailed prairie dog
		White-tailed prairie dog
		Red squirrel
		Fox squirrel
		Northern pocket gopher
X		Plains pocket gopher
		Olive-backed pocket mouse
		Hispid pocket mouse
X		Ord's kangaroo rat
		Beaver
		Plains harvest mouse
		Western harvest mouse
X	X	Deer mouse
		White-footed mouse
X	X	Northern grasshopper mouse
		Bushy-tailed woodrat
		Gapper's red-backed vole
X	X	Meadow vole
		Mountain vole
		Long-tailed vole
X	X	Prairie vole
		Sagebrush vole
X		Muskrat
X		House mouse
		Norway rat
		Meadow jumping mouse
X		Porcupine

Observed	Caught or Censused	Common Name
X		Coyote
X		Red fox
		Swift fox
X		Raccoon
		Short-tailed weasel
X		Long-tailed weasel
		Mink
		Black-footed ferret
X		Badger
		Spotted skunk
X		Striped skunk
		Mountain lion
		Bobcat
		Elk
X	X	Mule deer
		White-tailed deer
X	X	Pronghorn antelope
		Bison

CULTURAL RESOURCES

Following is list of sites eligible or possibly eligible for listing on the National Register of Historic Places, according to the Wyoming State Historic Preservation Officer and the Bureau of Land Management.

CAMPBELL COUNTY

Astorian Route (Hunt Party)
Bozeman Trail
Chicago, Burlington and Quincy Railroad Route
Cook's 17 Mile Stage Station
Gillette
Keeline Ranch
Kendrick Ranch
Lx Bar Ranch
Mooney Site
Nixon Ranch
Norfolk Petroglyphs
Pumpkin Buttes
Ritchie Bro's Ranch
Standard Cattle Co.
Texas Trail Branch
Weare Ranch
Wyodak Coal Mine
101 Ranch
Site 48 CA 12
Site 48 CA 89
Site 48 CA 130
Site 48 CA 302
Site 48 CA 402
Site 48 CA 403

CONVERSE COUNTY

Ada Magill Grave
Andrews and Hudson Ranch
Antelope Creek Ranch Road
Antelope Creek Station
Antelope Springs
Astorian Route (Stuart Party)
Ayres Natural Bridge
Barber Home, Glenrock
Bed Tick Station
Big Muddy Oil Field
Big Nose George Cabin Site
Bill Hooker Cabin Site
Bonnevilles Route
Box Elder Station
Boyd Bro's Ranch
Bozeman Trail
Bridgers Ferry
Bronco Building, Glenrock
Brown's Spring
Brown's Spring Ranch Road

Brown's Spring Station
Buckshot or Cross Ranch
Burlington Northern Railroad Depot, Douglas
California Trail (misnamed)
Caryhurst Ranch
Cheyenne Fork Stage Station
Chicago and Northwestern Railroad Route
Chicago Burlington and Quincy Railroad Route
Converse County Courthouse
City Hall, Douglas
Christ Episcopal Church, Douglas
Converse County Courthouse, Douglas
Cross Ranch
Deer Creek Station
Douglas
Elkhorn Station
Fetterman Road
Filbertson Ranch
Fort Fetterman (listed on Register April 16, 1969)
Glenrock
Glenrock Buffalo Jump (listed on Register April 16, 1969)
Hanna and McCanley Ranch
Harris Ranch
Hayden Survey Site
"Hog" Ranch (near Fort Fetterman)
House, 425 Center St., Douglas, Wy.
House, 406 Cedar Street, Douglas, Wy.
United Church of Christ, 8th and Birch, Douglas, Wy.
House, 214 N. 6th Street, Douglas, Wy.
House, 107 N. 6th Street, Douglas, Wy.
House, 139 S. 7th Street, Douglas, Wy.
House, 309 N. 3rd Street, Douglas, Wy.
Kennedy, J.H. Ranch
Keyser Ranch
LaBonte (Bill Hooker Monument)
LaBonte Creek Station
LaPrele Creek Station
Little Box Elder Creek Monument
Mormon Town
Mormon Trail (misnamed)
Moses Ranch
Moss Agate Road Ranch
Oregon Trail
Overland Trail (first route)
Parkerton Station (Chicago and N.W.R.R.)
Perry, J.F. Ranch
Point of Rocks Road Ranch
Pony Express Route
Rice Ranch
Rock Creek - Fort
Sage Creek Fight Site
Sage Creek Road Ranch
Sage Creek Station
Sand Creek Road Ranch

Sand Creek Station
Sheriff's Office, Douglas
Smith Ranch
Spanish Diggings
St. James Catholic Church, Douglas
Teschemacker and DeBillier Ranch
Unthank Grave
Williams Ranch
Site 48 CO 26
Site 48 CO 43
Site 48 CO 52
Site 48 CO 305

VISUAL RESOURCES

Visual Resource Inventory and Evaluation Procedures

The evaluation process described below has been recently developed by the Bureau of Land Management (BLM). A complete explanation of the procedure with examples of various phases appears in BLM Manual 6300 entitled "Visual Resource Management"

The overall objective is to provide a Bureauwide systematic approach for identifying scenery quality and setting minimum quality standards for management of the visual resource values on public land. The process places all public land into one of five visual resource management classes. Each of these classes contains a specific management objective for maintaining or enhancing visual resource values. The visual management class assigned to a given land area depends upon three factors:

1. the inherent quality of the scenery being viewed
2. the visual sensitivity level (the type of visual use it receives)
3. the visual zone it is in

Scenic Quality

The process assigns a rating of: A—high scenic quality, B—moderate scenic quality, or C—low scenic quality to all lands within a given area, not just those administered by BLM. The procedure, as shown in Table RB-8, analyzes six key factors: landform, color, water, vegetation, uniqueness, and intrusions. Each of these factors is rated against a set of general criteria and a score assigned accordingly. When the evaluation is complete on a given land unit, the individual key factor scores are totaled and the letter rating A, B, or C is assigned, depending upon the total points received.

The scenery quality ratings for the Eastern Powder River Basin of Wyoming are described below.

Scenery Quality A: The only A quality scenery identified in the region is the North Platte River valley in Converse County. The river valley is a unique feature because it supports a relatively lush growth of grasses, shrubs, and cottonwoods in an area otherwise characterized by sparse vegetation. Also, the volume of stream flow is substantially greater than for any other stream in the region.

Scenery Quality B: There are B quality scenery areas scattered throughout the region, most of which are associated with either a ponderosa pine or juniper tree vegetative cover and/or a moderate topographic feature variety. Oil and gas development, utility lines, and roads are the main intrusions in this category.

Scenery Quality C: The region is predominately in the C rating category; the landforms, textures, and color are more muted than the areas in the B category. The characteristic landscape consists of open country with rolling plains, broad river courses, low hills, and scattered buttes. Water is rarely seen. There is no visually significant variation or contrast created by vegetation. The major intrusions are ranches with their related structures, highways and roads, transmission lines, water wells and reservoirs, oil and gas sites, coal mines and related structures, railroad lines, power plants, and farmland.

Visual Sensitivity Levels

Visual sensitivity level are determined by people's concern for what see. Criteria selected for analyzing sensitivity are: (1) use volumes of highway and transportation routes; (2) land use values (local and regional); (3) community attitude; and (4) other agency planning attitudes. These criteria and evaluation factors are listed in Table RB-9.

Use volume along Interstate 90 is estimated at 1,900 vehicles for average daily travel (ADT). Use of State Highway 59 between Gillette and the existing mining areas south of Gillette is estimated at 1,410 ADT. Use of State Highway 59 between the Campbell-Converse county line and Bill is estimated at 680 ADT. Use of State Highway 59 north of Gillette near Weston is estimated at 440 ADT. Use of U.S. Highway 14/16 northwest of Gillette is estimated at 530 ADT (Wyoming Highway Department 1976).

Land use values are considered to determine attitudes toward the use of land for mining versus historic uses of ranching and wildlife habitat. In Gillette and Douglas, the concern for such a change is rated low. Residents outside the immediate areas of Gillette and Douglas are more concerned about maintaining historic land uses with moderate economic growth, and preserving state water rights and wildlife habitat. They are expected to consider mining a moderate infringement upon other land use values.

Community attitude is based on concern for the "quality of life"that may exist in a booming mining community. Visual intrusions caused by mining may well cause concern about the appearance and planning of communities. Based upon the mix of residents (short-term and long-term), the matter is rated as being of moderate concern.

Agency planning attitudes are considered only for cities and counties, as state or federal lands are too small and scattered to reflect planning and development standards. In this category, local planning attitude for visual resources is considered moderate.

Overall the high sensitivity areas for managing visual resources lie within the heavily travelled zones along major highways and within the communities.

Visual Zones

Visual zones identify visible areas from key observation points (highways, well-traveled roads, overlooks, recreation sites) according to one of three types:

Foreground-Middleground: Foreground-middleground is described as the area visible from a travel route or observation point for a distance of 3 to 5 miles. The outer boundary of this zone is defined as the point where the texture and form of individual plants are no longer apparent in the landscape.

KEY FACTORS	RATING CRITERIA AND SCORE		
① LAND FORM	Vertical or near vertical cliffs, spires, highly eroded formations, massive rock outcrops, severe surface variation. 4	Steep canyon walls, mesas, interesting erosional patterns, variety in size and shape of land forms. 2	Rolling hills, foothills, flat valley bottoms. 1
② COLOR	Rich color combinations, variety or vivid contrasts in the color of soil, rock, vegetation, or water. 4	Some variety in colors and contrast of the soil, rock and vegetation, but not dominant. 2	Subtle color variation, little contrast, generelly muted tones. Nothing really eye-catching. 1
③ WATER	Still, chance for reflections or cascading white water, a dominant factor in the lendscape. 4	Moving and in view or still but not dominant. 2	Absent, or present but seldom seen. 1
④ VEGETATION	A harmonious variation in form, texture, pattern, and type. 4	Some variation in pattern and texture, but only one or two major types. 2	Little or no variation, contrast lacking. 1
⑤ UNIQUENESS	One of a kind or very rare within region. 6	Unusual but similar to others within the region. 2	Interesting in its setting, but fairly common within the region. 1
⑥ INTRUSIONS	Free from aesthetically undesirable or discordant sights and influences. 2	Scenic quality is somewhat depreciated by inharmonous intrusions but not so extensive that the scenic qualities are entirely negated. 1	Intrusions are so extensive that scenic quelities are for the most part nullified. -4
Scenery A = 15 - 24 Scenery B = 10 - 14 Scenery C = 1 - 9			

EXPLANATION OF RATING CRITERIA

① Land Form or topography becomes interesting as it gets steeper and more massive. Examples of outstanding land forms are found in the Grand Canyon, the Sawtooth Mountain Range in Idaho, the Wrangle Mountain Renge in Alaska, end the Rocky Mountain National Park.

② Color Consider the overall color of the basic components of the landscape (i.e., soil, rocks, vegetation, etc.) as they eppear during the high-use season. Key factors to consider in rating "color" are variety, contrast, and harmony.

③ Water is the ingredient which adds movement or serenity to a scene. The degree to which water dominates the scene is the primary consideration in selecting the rating score.

④ Vegetation Give primary consideration to the variety of patterns, forms, and the texture created by the vegetation.

⑤ Uniqueness This factor provides an opportunity to give added importance to one or all of the scenic features thet appear to be relatively unique within any one physiographic region. There may also be cases where a separate evaluation of each of the key factors does not give a true picture of the overell scenic quality of an area. Often it is a number of not so spectacular elements in the proper combination that produces the most pleasing scenery - the uniqueness factor can be used to recognize this type of area and give it the added emphasis it needs.

⑥ Intrusions Consider the impact of man-made improvements on the aesthetic quality. These intrusions can heve a positive or negative aesthetic impact. Rate accordingly.

Table RB-8
SCENIC QUALITY RATING PROCEDURE

TABLE RB-9

CRITERIA FOR DETERMINING SENSITIVITY LEVEL

Criteria	High	Medium	Low
Use volume (Total use, no distinction between types)	More than 200 vehicles per day	20-200 vehicles per day	Less than 20 vehicles per day
Land use values			
Gillette and Douglas	Major	Secondary	Minor
Regional	Major	Secondary	Minor
Community attitude	Major	Secondary	Minor
Agency planning attitude	Major	Secondary	Minor

Background: Background is described as the area beyond the foreground-middleground, usually from a minimum of 3 to 5 miles to a maximum of about 15 miles from a travel route or use area. Atmospheric conditions in some areas may limit the maximum to about 8 miles or increase it beyond 15 miles.

Seldom Seen: All areas not identified in the two previous zones are considered to be in the seldom seen zone. Generally, these are areas seen from low use transportation routes or beyond the 15-mile background zone for other routes.

Visual Resource Management Classes

Following identification of the three evaluation factors, all areas of common characteristics are mapped and labeled.

Using the matrix shown in Table RB-10, one of five visual resource management classes is then assigned to each of the units with common characteristics. For example, all areas in Class B scenery, high sensitivity level, and the background visual zone would be in Visual Resource Management Class III.

Each class describes a different degree of modification allowed by a managing agency in the basic elements of the landscape.

Class I: This class provides for natural ecological changes only. It is applied to primitive areas, some natural areas, and similar situations where activities are to be restricted.

Class II: Changes in any of the basic elements (form, line, color, or texture) should not be evident in the characteristic landscape.

Class III: Changes in the basic elements (form, line, color, or texture) may be evident in the characteristic landscape. However, the changes should remain subordinate to the visual strength of the existing character.

Class IV: Changes may subordinate the original composition and character, but must reflect what could be a natural occurrence within the characteristic landscape.

Class V: Intrusions overlying one of the management classes (I-IV) are significant enough to jeopardize effective management until the intrusions are removed.

Regional visual resource management classes are delineated on Map 9, Appendix A.

	2/ VISUAL SENSITIVITY LEVEL						
	HIGH			MEDIUM			LOW
SPECIAL AREAS	I	I	I	I	I	I	I
1/ SCENERY CLASS A	II	II	II	II	II	II	II
B	II	III	IV	III	IV	IV	IV
C	III	IV	IV	IV	IV	IV	IV
	FG	BG	SS	FG	BG	SS	SS
	3/ VISUAL ZONES						

1/ SCENERY QUALITY INVENTORY (6310.11) — A, B, C

2/ VISUAL SENSITIVITY LEVEL (6310.12) — High, Medium, Low

3/ VISUAL ZONES (6310.13) — FG - Foreground - Middleground; BG - Background; SS - Seldom Seen

NOTE: Class I applies only to classified special areas, e.g., Wilderness, Primitive, Natural Areas, etc. This quality standard is established through legislation or policy.

Class V applies to areas identified in the scenery quality inventory where the quality class has been reduced because of unacceptable intrusions.

Table RB-10
VISUAL RESOURCE MANAGEMENT CLASS DETERMINATION

RECREATION RESOURCES

VISITOR USE STATISTICS

Bighorn National Forest	Increase (+) or Decrease (-) Over Previous Year
1972 - 1,135,800 Visitor Days	
1973 - 1,061,700	(-6.5%)
1974 - 981,000	(-7.6%)
1975 - 1,117,000	(+13.9%)
1976 - 1,244,500	(+11.4%)

Black Hills National Forest	
1970 - 1,765,000 Visitor Days	
1971 - 1,851,400	(+4.9%)
1972 - 1,632,000	(-11.9%)
1973 - 1,639,700	(+0.5%)
1974 - 1,501,300	(-8.4%)
1975 - 1,581,000	(+5.3%)
1976 - 2,306,500	(+45.9%)

Medicine Bow National Forest (Laramie Peak Ranger District)

1976 - 59,500 Visitor Days

1977 - Based on spring use, visitor use could reach 85,000+ visitor days.

Thunder Basin National Grasslands	1974 Recreation Use
Activity	Visitor Days
Auto Pleasure Driving	5,500
Motorcycle Driving	700
Horseback Riding	400
Snowcraft	1,200
Fishing	2,900
Camping	900
Picnicking	1,300
Hunting	12,000

The Forest Service estimates that visitation to the grasslands for 1976 is approximately the same as that reported for 1974. Forest Service statistics obtained by personal communication 1977.

Devils Tower National Monument	Increase (+) or Decrease (-) Over Previous Year
1970 - 147,444 Visitors	
1971 - 138,372	(-6.2%)
1972 - 149,306	(+7.9%)
1973 - 153,200	(+2.6%)
1974 - 125,592	(-18.0%)
1975 - 151,566	(+20.7%)
1976 - 169,754	(+12.0%)

Source: Personal communication, Wonder 1977

Wyoming State Parks Visitation

	Glendo		Guernsey		Keyhole	
1975	117,449	Visitors	82,583	Visitors	65,908	Visitors
1976	117,881	(+.4%)	79,847	(-3.3%)	100,049	(+51.8%)

Source: Wyoming Recreation Commission 1976

APPENDIX C

GLOSSARY

ACRE-FOOT. A term used in measuring the volume of water, equal to the quantity required to cover 1 acre to a depth of 1 foot, or 43,560 cubic feet.

ALBEDO. The ratio of the amount of electromagnetic radiation reflected by a body to the amount incident upon it.

ALLUVIAL TERRACE. Alluvium deposited in a narrow, relatively level band along the course of a stream, marking a former water level.

ALLUVIUM. Clay, silt, sand, gravel, or other rock material transported by flowing water and deposited as sediment.

AMBIENT CONCENTRATION. The ground-level pollutant concentration resulting from all sources, man-made or natural.

ANIMAL UNIT MONTHS. A measure of the forage or feed required to maintain one animal unit (a cow, a horse, or five sheep) for 1 month (30 days).

AQUIFER. A body of rock that is saturated with and conducts groundwater; a water-bearing formation that yields water to wells or springs.

ARTESIAN FLOW. The discharge of water from a well or spring by artesian pressure or hydrostatic pressure within a confined aquifer. A confined aquifer is one surrounded by less permeable rock layers.

CARRYING CAPACITY. The maximum number of all animals that an area can support during a given period of the year.

CATION-EXCHANGE SOFTENING. The natural exchange of calcium and magnesium ions in water for the sodium ions in clay. A similar exchange process occurs in household water softeners.

CLASS A PAN EVAPORATION RATE. The rate at which water evaporates into the atmosphere from a cylindrical pan 48 inches in diameter and 10 inches deep.

CLOSED-CANOPY FOREST. A forest in which the leaves and branches at the tops of the trees touch.

COLIFORM COUNT. The number of colonies of coliform bacteria in a given volume; an indication of the fecal contamination of water. Coliform bacteria inhabit the colons of warm-blooded animals.

COMMUNITY. An aggregation of organisms (plant or animal) within a specific area.

CONE OF DEPRESSION. A depression in the potentiometric surface of a body of groundwater. It develops around a well from which water is withdrawn or around a mine which intercepts an aquifer.

CRITICAL (OR CRUCIAL) WILDLIFE HABITAT. That portion of the habitat of a wildlife species that is essential to the survivial and perpetuation of that species, either as a population or as individuals.

DENDRITIC DRAINAGE PATTERN. A drainage pattern in which streams branch irregularly in all directions, resembling the branching pattern of trees.

DISCHARGE (GROUNDWATER). The removal of water from an aquifer.

DRAWDOWN. The difference between the static water level in an aquifer and that resulting from removal of water from the aquifer.

EPHEMERAL STREAM. A stream which flows only in response to precipitation or snowmelt.

EVAPOTRANSPIRATION RATE. The rate at which water is lost from the land area through transpiration of plants and evaporation from the soil.

FAULT. A zone of rock fracture along which there has been displacement.

FUGITIVE DUST. Dust particles made airborne by wind or man's activities. Common sources include unpaved roads, construction sites, and tilled land.

HEADCUTTING (SCALPING). An upvalley movement of a stream gully as flowing water cuts or erodes soil into the channel. The gully resulting from headcutting is so deep it cannot be crossed by wheeled vehicles or eliminated by plowing.

HORIZON (SOIL). A layer of soil, approximately parallel to the surface, that has characteristics of color, structure, or texture distinct from other layers.

INFILTRATION RATE. The rate at which soil can absorb falling rain or melting snow.

INTERMITTENT STREAM. A stream which flows only part of each year.

ISOPLETH. A line on a map connecting points at which a given variable, such as air pollutant concentration, has a constant value.

LAKE EVAPORATION. The amount of water which evaporates from a body of water during a given period of time.

LEACHATE. A solution obtained by leaching.

LEACHING. The removal in solution of soluble constituents (such as mineral salts or organic matter) from an upper to a lower soil or rock layer by water draining through them.

LENTICULAR FORMATION. A lens-shaped body of rock, thick in the middle and thinning toward the edges.

LIMITING FACTOR. The living or nonliving factor of the environment which is in least supply and which is critical to survivial of a plant or animal.

LITHIC MATERIAL. Any stone material worked by man--flakes, tools, or debitage from tool production and maintenance.

LITHOLOGY. The physical character of rock.

"MAJOR" STATIONARY SOURCE. A facility which has uncontrolled emissions greater than 250 tons per year of any criteria pollutant, or greater than 100 tons per year of sulfur dioxide or particulates.

MIXING HEIGHT. The height above the ground below which turbulence causes the air to be well mixed.

ORGANIC COMPOUND. A compound containing carbon, especially in which hydrogen is attached to carbon.

ORGANIC MATTER. Any material derived from living things, as opposed to mineral or inorganic matter. The organic matter in soil consists primarily of the remains of plants.

OXIDATION. The process by which a chemical is changed by combining it with oxygen, or by increasing the proportion of its electronegative parts.

PARENT MATERIAL. The unconsolidated, weathered mineral or organic material from which soil develops.

PARTING. A band of waste material, such as shale, which divides layers of coal.

PERCHED GROUNDWATER. Groundwater perched on an impermeable rock lens and separated from an underlying body of groundwater by unsaturated rock.

PERENNIAL STREAM. A stream that flows continuously throughout the year.

PERMEABILITY. The capacity of a porous rock or sediment for transmitting fluid.

PERMEABILITY RATE (SOIL). The rate at which water passes through a layer of soil.

pH. An expression of acidity or alkalinity, measured on a scale of 0 through 14, on which 7 represents neutrality. Values less than 7 represent increasing hydrogen ion concentration (increasing acidity). Values greater than 7 represent decreasing hydrogen ion concentration (increasing alkalinity).

PHOTOCHEMICAL OXIDANT. A secondary pollutant formed in a photochemical reaction involving hydrocarbons and oxides of nitrogen.

PICOCURIE. One trillionth of one curie. A curie is a measure of radioactivity equal to 3.7×10^{10} disintegrations per second.

PLAYA. A shallow, completely closed (undrained) basin where water collects (as after a rain) and quickly evaporates, often leaving deposits of soluble salts.

POINT-WATERING SOURCE. A pool in the bed of an intermittent stream, or any spring, well, or stockpond where livestock and wildlife can obtain water.

POTENTIOMETRIC SURFACE. An imaginery surface representing the static head of groundwater and defined by the level to which water will rise in a well. The water table is a particular potentiometric surface.

PREFERENCE RIGHT COAL LEASE APPLICATION. An application for a federal coal lease for which the applicant has established a preferential or first right through his initiative in prospecting for and demonstrating the occurrence of commercial quantities of coal.

PRODUCTIVE CAPACITY. The weight of forage that is produced within a designated period of time on a given area. In this document, productive capacity refers to pounds of air-dry forage produced on 1 acre in 1 year.

RAPTOR. A bird of prey, such as a hawk, eagle, or owl; a bird that feeds on meat taken by hunting.

RECHARGE (GROUNDWATER). The addition of water to an aquifer.

REDUCTION. The process by which a chemical is changed by combining it with hydrogen, or by decreasing the proportion of its electronegative parts.

RIPARIAN VEGETATION. Vegetation associated with or growing along a stream or river.

SCORIA. The local name for clinker or porcellanite; baked clay or shale with a dull, light-colored appearance, often found in the roof or floor of a burned-out coal seam.

SECONDARY AND TERTIARY OIL RECOVERY. Methods by which water is pumped into an oil-bearing formation to increase pressure in the formation and allow extraction of an oil-water mixture which can then be separated. These methods are used only after primary production (extraction by pressure in the oil pool alone) is no longer economical.

SEDIMENTATION. The process by which rock particles are eroded, transported and deposited, usually by flowing water.

SHEET EROSION. Erosion caused by sheets of flowing water, as distinct from erosion by streams flowing in channels.

STATIC HEAD. The height above a reference level of the surface of a column of water that can be supported by the static pressure at a given point.

STORAGE COEFFICIENT. The volume of water released from storage in a vertical column of 1.0 square feet when the water table or other potentiometric surface declines 1.0 feet.

STRATIFIED SITE. A site at which more than one component or layer of cultural materials is present. Lower layers are older than upper ones.

STRUCTURAL DEPRESSION (BASIN). An area which is depressed and filled with sediment, bordered (in Wyoming) by faulted and uplifted rock.

STRUCTURAL RELIEF. The difference in elevation between the highest and lowest points of a formation or layer of rock in a given region.

STRUTTING GROUND. An area of open ground used year after year by sage grouse for courtship displays.

SURFACE-BASED INVERSION. A layer of air near the ground in which temperatures increases with altitude, the result being a zone in which pollutants become trapped rather than dispersing.

SYNCLINE. An elongated fold in rocks, the core of which is composed of stratigraphically younger rocks. A syncline is concave upward.

TEMPERATURE INVERSION LAYER. See surface-based inversion.

TOTAL SUSPENDED PARTICULATES. That portion of all particulate matter in the atmosphere consisting of particles too small to settle out.

TRANSMISSIVITY. In an aquifer, the rate at which water at the prevailing temperature is transmitted through a unit width under a unit hydraulic gradient.

UNDERSTORY. A layer of vegetation underlying a layer of taller plants.

WILDINGS. Seedlings or young plants naturally produced outside a nursery and dug for use as planting stock.

APPENDIX D

REFERENCES CITED

Amax Coal Company

1976 Comprehensive Mining and Reclamation Plan, Belle Ayr South Mine, Campbell County, Wyoming.

1977 Comprehensive Mining and Reclamation Plan, Eagle Butte Mine, Campbell County, Wyoming.

American Hospital Association

1976 Guide to the Health Care Field, 1976. Chicago.

1976 Hospital Statistics, 1976. Chicago.

American Society of Civil Engineers 1977. Impact of Energy Development on Ground Water. Task Committee on Ground Water Hydrology, April 25-29, 1977, Preprint 2911. New York.

Anderson, Keith E., and Kelly, Jack E. 1976. Exploration for Ground Water in the Madison Limestone, Niobrara County, Wyoming. Wyoming Geological Association 28th Annual Field Conference Guidebook: Geology and Energy Resources of the Powder River. Laramie, Wyoming.

Arro, Eric 1976. Deadman Creek Field. Wyoming Geological Association 28th Annual Field Conference Guidebook: Geology and Energy Resources of the Powder River. Laramie, Wyoming.

Atlantic Richfield Company

1977 Mining and Reclamation Plan for the Black Thunder Coal Mine, Campbell County, Wyoming.

1977 Mining and Reclamation Plan, Coal Creek Mine.

Averitt, Paul 1975. Coal Resources of the United States, January 1974. U.S. Geological Survey Bulletin 1412.

Baldwin, M.; Kellogg, Charles E.; and Thorp, J. 1938. Soil Classification. Soils and Men. U.S. Department of Agriculture Yearbook.

Becker, C. F., and Alyea, J. D.

1964a Precipitation Probabilities in Wyoming. Agriculture Experiment Station Bulletin 416. Laramie, Wyoming: University of Wyoming.

1964b Temperature Probabilities in Wyoming. Agriculture Experiment Station Bulletin 415. Laramie, Wyoming: University of Wyoming.

Bickert, Browne, Coddington, and Associates, Inc. 1976. An Analysis of Energy Consumption in Wyoming. Prepared for the Bureau of Land Management.

Blevins, Audie L., Jr.; Thompson, James G.; and Ellis, Carl 1974. Social Impact Analysis of Campbell County, Wyoming. Prepared for the Wyoming Environmental Institute under contract with Atlantic Richfield Company.

Bradley, Jim 1976. Report from Fort Apache or Crime and Violence in Southwest Wyoming. Unpublished report for Wyoming Game and Fish Department.

Brady, N. C. 1974. The Nature and Properties of Soils. 8th edition. New York: MacMillan.

Breckenridge, Roy M.; Glass, Gary B.; Root, Forrest K.; and Wendell, William G. 1974. Campbell County, Wyoming: Geologic Map Atlas and Summary of Land, Water, and Mineral Resources. County Resource Series No. 3. Laramie, Wyoming: Wyoming Geological Survey, published in cooperation with the Wyoming Department of Economic Planning and Development and the U.S. Bureau of Mines.

Campbell County Recreation Board 1974. Campbell County Recreation Study.

Carter Mining Company
1977 Caballo Mine Plan Update.
1977 Rawhide Mine Plan Update.

Casper Star-Tribune, March 27, 1978. Coal Train Splits Town of Gillette in Two. Casper, Wyoming.

Centaur Management Consultants, Inc. 1978. Draft reports on socioceconomic environment and impacts, Eastern Powder River Basin. Prepared for the Bureau of Land Management.

Changnon, Stanley A., Jr., 1977. Scales of Hail. Journal of Applied Meteorology 16:626-648, June 1977.

City of Gillette/Campbell County Department of Planning and Development
1977 Citizens' Policy Survey.
1978 Comprehensive Planning Program (second draft).

Clark, Don A., and Kerr, Robert S. 1974. State-of-the-Art: Uranium Mining, Milling, and Refining Industry. Environmental Protection Technology Series, U.S. Environmental Protection Agency Publication 660/2-74-038.

Clark, Tim W. 1977. Black-Footed Ferrets and Prairie Dogs in Wyoming: 5 Yr (1973-77) Summary of Research. Unpublished paper, Idaho State University, Pocatello, Idaho.

Conner, J. J.; Keith, J. R.; and Anderson, Barbara M. 1976. Trace Metal Variation in Soils and Sagebrush in the Powder River Basin, Wyoming and Montana. U.S. Geological Survey Journal of Research 4(1):49-59.

Consolidation Coal Company 1976. Mining and Reclamation Plan for Phase I Mining (Pronghorn).

Cook, C. W.; Hyde, R. M.; and Simms, P. L. 1974. Guidelines for Revegetation and Stabilization of Surface Mined Lands in the Western States. Range Science Service No. 16. Fort Collins, Colorado: Colorado State University.

Cordero Mining Company 1976. Update of Mining and Reclamation Plan, Cordero Coal Mine (Existing), Campbell Co., Wyoming.

Cowherd, Chatten; Axetell, Kenneth, Jr.; Guenther, Christine; and Jutze, George 1974. Development of Emission Factors for Fugitive Dust Sources. U.S. Environmental Protection Agency Publication 450/3-74-037.

Curry, D. L. 1976. Evaluation of Uranium Resources in the Powder River Basin of Wyoming. Wyoming Geological Association 28th Annual Field Conference Guidebook: Geology and Energy Resources of the Powder River. Laramie, Wyoming.

Dahl, A. R., and Hagmaier, J. L. 1976. Genesis and Characteristics of the Southern Powder River Basin Uranium Deposits, Wyoming. Wyoming Geological Association 28th Annual Field Conference Guidebook: Geology and Energy Resources of the Powder River. Laramie, Wyoming.

Davis, Richard W., and Rechard, Paul A. 1977. Effects of Surface Mining upon Shallow Aquifers in the Eastern Powder River Basin, Wyoming. Water Resources Series No. 67. Laramie, Wyoming: University of Wyoming, Water Resources Research Institute.

Denson, N. M., and Keefer, W. R. 1974. Coal Resources of the Gillette Area, Wyoming. U.S. Geological Survey Miscellaneous Investigations Map I-848-D.

Denver Research Institute 1977. Impacts of the Proposed Mobil-Consol Pronghorn Mine on Local Public Finance. Prepared for Consolidation Coal Company.

Dobbin, D. E., and Barnett, B. H. 1927. The Gillette Coal Field of Eastern Wyoming. U.S. Geological Survey Bulletin 796.

Dunrud, Richard C., and Osterwald, Frank W. 1978. Effects of Coal Mine Subsidence in the Western Powder River Basin, Wyoming. U.S. Geological Survey Open File Report 78-473.

Ecology Consultants, Inc.

1976 — Wyodak to Antelope 230 kv Transmission Line. Applicant's Environmental Analysis, prepared for Tri-County Electric Association, Inc.

1977. — Environmental Impact Assessment for the Proposed Buckskin Mine. Prepared for Shell Oil Company.

Energy Transportation Systems, Inc. (ETSI) 1978. ETSI coal slurry pipeline information brochure.

Engineering and Mining Journal 1975. See White, L.

Ettinger, Harry J., and Royer, George W. 1972. Visibility and Mass Concentration in a Nonurban Environment. Air Pollution Control Association Journal 22:108-111, February 1972.

Federal Register

April 30, 1971 — National Primary and Secondary Ambient Air Quality Standards.

February 1, 1977 — National Register of Historic Places.

July 14, 1977 — Endangered and Threatened Wildlife and Plants. Republication of List of Species.

December 13, 1977 — Surface Mining Reclamation and Enforcement Provisions.

Fenneman, Nevin M. 1931. Physiography of the Western United States. New York: McGraw-Hill.

Flora, Snowden D. 1956. Hailstorms of the United States. Norman, Oklahoma: University of Oklahoma Press.

Frary, Maryann 1974. Douglas Watershed Survey: History and Archeology. Unpublished report, Casper College, Casper, Wyoming.

French, C. L. 1974. Attitudes of Johnson County, Wyoming Residents toward Selected Aspects of Their Environment. Prepared for the Northern Great Plains Resource Program.

Freudenburgh, William R. 1976. Social Impact of Energy Boom-Town Development on Rural Communities: A Review of the Literature and Some Predictions. Unpublished report, Yale University, New Haven, Connecticut.

Freudenthal, David D.; Ricciardelli, Peter; and York, Michael N. 1974. Coal Development Alternatives: An Assessment of Water Use and Economic Implications. A report prepared by the Wyoming Department of Economic Planning and Development for the Wyoming Legislative Special Subcommittee on Comsumptive Water Use.

Frison, George C.

1971 — The Bison Pound in Northwestern Plains Prehistory. American Antiquity 36:77-91.

1978 — Prehistoric Hunters and Gatherers in the Northwest Plains. New York: Academic Press.

Gill, Douglas 1978. List of Active, Planned Coal and Uranium Mining Operations is Lengthening. Western Oil Reporter 35(2):41-51.

Gilmore, John 1976. Boom Towns May Hinder Energy Resource Development. Science 191:535-540, February 13, 1976.

Glass, Gary B.

1976. — Update on the Powder River Coal Basin. Wyoming Geological Association 28th Annual Field Conference Guidebook: Geology and Energy Resources of the Powder River. Laramie, Wyoming.

1976a — Review of Wyoming Coal Fields, 1976. Wyoming Geological Survey, Public Information Circular 4. Laramie, Wyoming.

Gold, Raymond 1974. A Comparative Study of the Impact of Coal Development on the Way of Life of People in the Coal Areas of Eastern Montana and Northeastern Wyoming. Missoula, Montana: University of Montana, Institute for Social Science Research.

Hadley, R. F., and Schumm, S. A. 1961. Sediment Sources and Drainage Basin Characteristics in the Upper Cheyenne River Basin. U.S. Geological Survey Water Supply Paper 1531-B.

Harbridge House, Inc. 1976. Social-Economic Profile of the Casper District. Prepared for the Bureau of Land Management.

Hardaway, John E.; Kimball, Dan B.; Lindsay, Shirley F.; Schmidt, Jack; and Erickson, Larry 1977. Subirrigated Alluvial Valley Floors: A Reconnaissance of Their Properties and Occurrence on Coal Resource Lands in the Interior Western United States. U.S. Environmental Protection Agency.

Harza Engineering Company 1976. Analysis of Energy Projections and Implications for Resource Requirements. Prepared for Missouri River Basin Commission, Yellowstone Level B. Study. Chicago, Illinois.

Helmer, John T. 1977. What is a Stream? Reclamation for Wildlife Habitat. Proceedings of Reclamation Workshop II, sponsored by Ecology Consultants, Inc., Fort Collins, Colorado, September 19-20, 1977.

Hershfield, David M. 1961. Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years. U.S. Weather Bureau Technical Paper No. 40.

Hodson, Warren G.

1971 Chemical Analyses of Ground Water in the Powder River Basin and Adjacent Areas, Northeastern Wyoming. U.S. Geological Survey Basic Data Report.

1974 Records of Water Wells, Oil-and-Gas Test Holes, and Chemical Analyses of Water for the Madison Limestone and Equivalent Rocks in the Powder River Basin and Adjacent Areas, Northeastern Wyoming. Prepared by U.S. Geological Survey. Cheyenne, Wyoming: Wyoming State Engineer.

Hodson, Warren G.; Pearl, R. H.; and Druse, S. A. 1973. Water Resources of the Powder River Basin and Adjacent Areas, Northeastern Wyoming. U.S. Geological Survey Hydrologic Investigations Atlas HA-465.

Holzworth, George C. 1972. Mixing Heights, Wind Speeds, and Potential for Urban Air Pollution Throughout the Contiguous United States. U.S. Environmental Protection Agency Publication No. AP-101.

Hosler, Charles R. 1969. Low-Level Inversion Frequency in the Contiguous United States. Monthly Weather Review 89(9):319-339.

Intermountain Planners, Inc., and Wirth-Berger Associates 1975. Powder River Basin Capital Facilities Study. Prepared for the Wyoming Department of Economic Planning and Development. Cheyenne, Wyoming.

James, L. F., and Cronin, E. H. 1974. Management Practices to Minimize Losses of Sheep Grazing Halogeton-Infested Range. Journal of Range Management 27(6):424-426.

Keefer, William R. 1974. Geologic Map of the Northern Great Plains. Prepared for the Northern Great Plains Resources Program. U.S. Geological Survey Open File Report 74-50.

Keefer, W. R., and Hadley, R. F. 1976. Land and Natural Resource Information and some Potential Environmental Effects of Surface Mining of Coal in the Gillette Area, Wyoming. U.S. Geological Survey Circular 743.

Keenlyne, Kent D. 1977. Endangered or Threatened Species in Wyoming. U.S. Fish and Wildlife Service Special Report No. 3.

Kerr-McGee Corporation 1977. Southern Powder River Basin Mill Environmental Report.

Kerr-McGee Coal Corporation
1977 Mining and Reclamation Plan, East Gillette Mine, Campbell County, Wyoming.
1977 Mining and Reclamation Plan, Jacobs Ranch Mine, Campbell County, Wyoming.

Klingman, Glenn C. 1961. Weed Control as a Science. New York: John Wiley and Sons.

Knight, S. H. 1958. Relief Map of the Powder River Basin and Adjacent Mountains. Wyoming Geological Association 13th Annual Field Conference Guidebook: Powder River Basin. Laramie, Wyoming.

Kohrs, Eldean V. 1974. Social Consequences of Boom Town Growth in Wyoming. Paper given at meeting of Rocky Mountain American Association for Advancement of Science, April 24-26, 1974, Laramie, Wyoming.

Konikow, Leonard F. 1976. Preliminary Digital Model of Ground Water Flow in the Madison Group, Powder River Basin and Adjacent Areas, Wyoming, Montana, South Dakota, North Dakota, and Nebraska. U.S. Geological Survey Water Resources Investigations 63-75.

Landsberg, Helmut 1969. Physical Climatology. 2nd edition. DuBois, Pennsylvania: Gray Printing Company.

Larsen, Ralph I. 1971. A Mathematical Model for Relating Air Quality Measurements to Air Quality Standards. U.S. Environmental Protection Agency.

Locke, Ben Z., and Duvall, Henrietta J. 1964. Migration and Mental Illness. Eugenics Quarterly 11(4):216-221.

Lowham, H. W. 1976. Techniques for Estimating Flow Characteristics of Wyoming Streams. U.S. Geological Survey Water Resources Investigations 76-112.

Lusby, Gregg C., and Toy, Terrence J. 1976. An Evaluation of Surface Mine Spoil Area Restoration in Wyoming Using Rainfall Simulation. Earth Surface Processes, Volume I. New York: John Wiley and Sons.

Massey, Garth 1977. Newcomers in an Impacted Area of Wyoming. Prepared for the Center for Studies of Metropolitan Problems, National Institute of Mental Health.

May, Morton 1975. Moisture Relationships and Treatments in Revegetating Strip Mines in the Arid West. Journal of Range Management 28(4):334-335.

Metronics

1976 Cordero Mine Site. Prepared for Sun Oil Company.

1976 Panhandle Eastern South Plant Site. Prepared for Panhandle Eastern Pipe Line Company.

Midwest Research Institute 1974. Development of Emission Factors for Fugitive Dust Sources. Prepared for the U.S. Environmental Protection Agency.

Monsen, Stephen B. 1975. Selecting Plants to Rehabilitate Disturbed Areas. U.S. Forest Service, Intermountain Forest and Range Experiment Station.

Mountain West Research, Inc. 1977. Economic/Demographic Assessment Manual. Denver.

Mulloy, William 1958. A Preliminary Historical Outline for the Northwestern Plains. University of Wyoming Publication in Science 22(122):126-140.

Murray, Robert A. 1974. Regional History Study. Prepared for the Bureau of Land Management by Western Interpretive Services.

National Climatic Center

1948-1954 Surface Meteorological Tape for Douglas, Wyoming--TDF 1440 DATA FORMAT.

1950-1952 Surface Meteorological Tape for Moorcroft, Wyoming--TDF 1440 DATA FORMAT.

1968 Wind Direction by Pasquill Stability Classes, STAR Program.

1970-1974 Surface Meteorological Tape for Casper, Wyoming--TDF 1440 DATA FORMAT.

1972-1975 Upper Air Meteorological Tape for Glasgow, Montana--TDF 56 DATA FORMAT.

1972-1975 Upper Air Meteorological Tape for Rapid City, South Dakota--TDF 56 DATA FORMAT.

National Oceanic and Atmospheric Administration 1974. Western States, Alaska, Hawaii. Climates of the States, Volume 2. Port Washington, New York: Water Information Center, Inc.

Nehring, Richard; Zycher, Benjamin; and Wharton, Joseph 1976. Coal Development and Government Regulation in the Northern Great Plains: A Preliminary Report. R-1981-NSF/RC.

Northern Energy Resources Company (Pacific Power and Light Company) 1977. Modification of Mining and Reclamation Plan for Dave Johnston Mine, Converse County, Wyoming.

Nuclear Regulatory Commission 1977. Bear Creek Project Final Environmental Statement.

Oakes, Kathleen M. 1976. Vertebrates of Coal Creek, Wyoming. Master's Thesis, University of Wyoming, Laramie, Wyoming.

Old West Regional Commission 1975. Construction Worker Profile, Community Report: Rock Springs and Green River, Wyoming. Denver: Mountain West Research, Inc.

Orgill, M. M., and Sehmel, G. A. 1976. Frequency and Diurnal Variation of Dust Storms in the Contiguous U.S.A. Atmospheric Environment 10(10):813-825.

Paananen, O.; Blevins, A. L., Jr.; Thompson, J. G.; Ellis, C.; and Potter, K. 1976. Socioeconomics. Final Environmental Assessment, Black Thunder Mine Site, Campbell County, Wyoming. Laramie, Wyoming: University of Wyoming, Black Thunder Project Research Team.

Packer, Paul E. 1974. Rehabilitation Potentials and Limitations of Surface-Mined Land in the Northern Great Plains. U.S. Forest Service General Technical Report INT-14.

Peabody Coal Company (Rochelle Coal Company) 1977. Mining and Reclamation Plan for Proposed Rochelle Mine.

PEDCo Environmental

1976 Wyoming Air Quality Maintenance Area Analysis. Prepared for the U.S. Environmental Protection Agency.

1978 Draft and technical reports on climate and air quality environment and impacts, proposed Buckskin Mine project. Prepared for the Bureau of Land Management.

1978a Survey of Fugitive Dust from Coal Mines. Prepared for the U.S. Environmental Protection Agency.

Public Service Commission 1978. State Supplement to R-1 Annual Reports of Burlington Northern, Inc., 1973-1977. Cheyenne, Wyoming.

Radian Corporation

1977 Air monitoring report for Buckskin Mine project. Prepared for Shell Oil Company.

1978 Draft and technical reports on climate and air quality environment and impacts, Eastern Powder River Basin. Prepared for the Bureau of Land Management.

Rahn, Perry 1976. Potential of Coal Strip-Mine Spoils as Aquifers in the Powder River Basin. Old West Project No. 10470025. Billings, Montana: Old West Regional Commission.

Riffenburg, H. B. 1925. Chemical Character of Ground Waters of the Northern Great Plains. U.S. Geological Survey Water Supply Paper 560-B.

Rounsaville, Hayden D. 1976. Soil Investigation Specifications for Mining and Reclamation Proposals. U.S. Forest Service.

Sales and Marketing Management 117:A7-D36, July 26, 1976, and 7-193, October 25, 1976. Survey of Buying Power.

Schick, Robert J. (undated). Wyoming's Air Quality Ambient Air Monitoring Data, 1972-1975. Wyoming Department of Environmental Quality, Air Quality Control Division.

SERNCO 1974. Applicant's Environmental Assessment for a Proposed Gasification Project in Campbell and Converse Counties, Wyoming. Prepared for Wyoming Coal Gas Company and Rochelle Coal Company.

Shell Oil Company 1977. Buckskin Mine Mining and Reclamation Plans.

The Sheridan Press, February 9, 1978. Studies to Improve Crossing Underway. Sheridan, Wyoming.

Shown, L. M.; Hadley, R. F.; and Ringen, B. H. (report in preparation). Sediment Yield from Mined Areas. Prepared for U.S. Geological Survey Project, Reconnaissance Techniques for Evaluation of the Rehabilitation Potential of Energy-Resource Lands, CR75-104 FI.

Simon, Ruth B. 1972. Seismicity. Geologic Atlas of the Rocky Mountain Region. Denver: Rocky Mountain Association of Geologists.

Smith, J. B.; Ayler, M. F.; Knox, C. C.; and Pollard, B. C. 1972. Strippable Coal Reserves of Wyoming: Location, Tonnage, and Characteristics of Coal and Overburden. U.S. Bureau of Mines Information Circular 8538.

Sun Oil Company 1974. Environmental Study of the Biological Conditions, Belle Fourche Coal Project, Campbell County, Wyoming.

Swenson, F. A.; Miller, W. R.; Hodson, W. G.; and Visher, F. N. 1976. Maps Showing the Configuration and Thickness, Potentiometric Surfaces, and Water Quality in the Madison Group, Powder River Basin, Wyoming and Montana. U.S. Geological Survey Miscellaneous Investigations Map I-847C.

Tennessee Valley Authority 1976. Final Environmental Statement, Morton Ranch Uranium Mining.

Texas Almanac 1975. Weather. Dallas: A. H. Belo Corporation.

Thames, John L., ed. 1977. Reclamation and Use of Disturbed Land in the Southwest. Tucson, Arizona: University of Arizona Press.

Thom, H. C. S.

1963 Tornado Probabilities. Monthly Weather Review ____:730-736.

1968 New Distributions of Extreme Winds in the United States. Proceedings of the American Society of Civil Engineers 94(ST 7 No. 6038):1787-1801, July 1968.

Thompson, J.; Blevins, A.; and Ellis, C. 1975. A Social Assessment of the Proposed Laramie River Station in Platte County, Wyoming. Laramie, Wyoming: University of Wyoming.

Trewartha, Glenn T. 1961. The Earth's Problem Climates. Madison, Wisconsin: University of Wisconsin Press.

Turner, D. B. 1972. Workbook of Atmospheric Dispersion Estimates. U.S. Environmental Protection Agency Publication No. AP-26.

Uhlmann, Julie M., et al. 1976. A Study of Two Wyoming Communities Undergoing the Initial Effects of Energy Resource Development in the Powder River Basin. Prepared for the Wyoming Department of Economic Planning and Development by the University of Wyoming, Laramie, Wyoming.

United Nuclear Corporation 1977. Morton Ranch Mill Environmental Report.

University of Wyoming

- 1976 Final Environmental Assessment, Black Thunder Mine Site, Campbell County, Wyoming. Black Thunder Project Research Team. Laramie, Wyoming.
- 1976 Campbell County Parks and Recreation Department Citizens' Survey. Human Services Project. Laramie, Wyoming.
- 1978 Water Resources Research Institute Model.

U.S. Department of Agriculture, Crop and Livestock Reporting Service 1972. Livestock Numbers, Campbell and Converse Counties.

U.S. Department of Agriculture, Rural Electrification Administration 1976. Final Environmental Impact Statement, Missouri Basin Power Project (Wheatland Generating Station Units 1, 2, and 3 and Associated Transmission, and Grayrocks Reservoir).

U.S. Department of Agriculture, Soil Conservation Service

- 1955 Soil Survey--Campbell County, Wyoming.
- 1960 Soil Classification, A Comprehensive System, 7th Approximation.
- 1973 Land Capability Classification, U.S. Department of Agriculture Handbook No. 210.
- 1975 Soil Taxonomy: A Basic System of Soil Classification for Making and Interpreting Soil Surveys. U.S. Department of Agriculture Handbook No. 436.

U.S. Department of Commerce 1898-1975. Climatological Data: Wyoming Section 7(10):84.

U.S. Department of Commerce, Bureau of the Census

- 1969 Census of Agriculture.
- 1970 1970 Census of Population: Characteristics of the Population.
- 1972 1970 Census of Housing, Housing Statistics for States, Cities, and Counties.
- April 1977 Current Population Reports, Population Estimates, and Projections, Series P-25, No. 698.
- Nov. 1977 Current Population Reports, Federal-State Cooperative Program for Population Estimates, Series P-26, No. 76-40.

U.S. Department of Commerce, Bureau of Economic Analysis 1977. Local Area Personal Income, 1970-75.

U.S. Department of Commerce, Environmental Data Service 1968. Climatic Atlas of the United States.

U.S. Department of Commerce, Environmental Science Services Administration 1969. Severe Storm Occurrences, 1955-1967. Technical Memorandum, WBTM, FCST 12.

U.S. Department of the Interior, Bureau of Land Management
1974 Final Environmental Impact Statement, Eastern Powder River Coal Basin of Wyoming.
1975 Hanna Basin Study Site, EMRIA Report No. 2.
1976a Hanna Basin Study Site, EMRIA Report No. 7.
1976b Final Environmental Statement, Northwest Colorado Coal.
1977 Unit Resource Analysis, Campbell and Converse Counties.

U.S. Department of Housing and Urban Development, Office of Community Planning and Development 1976. Rapid Growth from Energy Projects, Ideas for State and Local Action--A Program Guide. 701 Comprehensive Planning Program in cooperation with the Federal Energy Administration.

U.S. Department of Transportation, Office of the Secretary 1978. Transporting the Nation's Coal--A Preliminary Assessment. Coal Transportation Task Force.

U.S. Environmental Protection Agency
1976 Air Quality Data--1974 Statistics.
1977 National Emission Data System, county emission reports for Converse, Campbell, Natrona, and Crook counties.
1978 Air Quality Control Regions, Criteria, and Control Techniques.

U.S. Environmental Protection Agency, Office of Air and Waste Management and Office of Air Quality Planning and Standards 1976. Compilation of Air Pollution Emission Factors. Publication No. AP-42.

U.S. Environmental Protection Agency, Office of Transportation and Land Use Policy 1978. Motor Vehicle Emission Factors, Final Document.

Western Oil Reporter 1978. See Gill, Douglas.

Wheeler, Richard P. 1949. Preliminary Appraisal of the Archeological Resources of Moorhead Reservoir, Powder River County, Montana and Sheridan and Campbell Counties, Wyoming. Lincoln, Nebraska: Missouri River Basin Survey, Smithsonian Institution.

White, L. 1975. Wyoming Uranium Mines Set Sights on Higher Production. Engineering and Mining Journal 176:61-71, December 1975.

Williams, Van, in press. Surficial Geologic Map of the Rawhide School Quadrangle, Campbell County Wyoming. U.S. Geological Survey Map MF 978.

Wyodak Resources Development Corporation 1976. Federal Mining Plan, Wyodak North Pit Mine.

Wyoming Department of Economic Planning and Development, Industrial Planning Division 1977. *Community Profiles*. Cheyenne, Wyoming.

Wyoming Department of Economic Planning and Development, Minerals Division 1978. *Mineral Development Monitoring System*.

Wyoming Department of Economic Planning and Development, Planning Division 1977. *Housing Finance*. Cheyenne, Wyoming.

Wyoming Department of Education, Division of Planning, Evaluation, and Information Services, 1974 through 1977. *Fall Report of Staff Teachers/Pupils/Schools/Enrollments*. Statistical Report Series No. 2. Cheyenne, Wyoming.

Wyoming Department of Environmental Quality
- 1976 *Wyoming Air Quality Maintenance Area Analysis*. Cheyenne, Wyoming.
- 1977 *Wyoming's Air Quality, Ambient Air Monitoring Data-1976*. Cheyenne, Wyoming.
- 1978 Wyodak Plant permit file.

Wyoming Department of Health and Social Services, Division of Comprehensive Health Planning 1977. *Wyoming Health Profiles*. Cheyenne, Wyoming.

Wyoming Department of Labor and Statistics 1977. Wyoming cost of living index for the first and third quarters.

Wyoming Department of Revenue and Taxation, Ad Valorem Tax Division 1977. *1977 Annual Report*. Cheyenne, Wyoming.

Wyoming Game and Fish Department
- 1975 *A Strategic Plan for the Comprehensive Management of Wildlife in Wyoming 1975-1980*. Volume I. Cheyenne, Wyoming.
- 1977 *Current Status and Inventory of Wildlife in Wyoming*. Cheyenne, Wyoming.
- 1977a *Statewide Comprehensive Manual*
- 1978 An Assessment of the Fishes and Aquatic Habitat in the Eastern Powder River Region of Wyoming. Wyoming Ornithology: A History and Bibiography of the Mammals of Wyoming and Adjacent States with Special Reference to Density and Habitat Affinity. Prepared for the Bureau of Land Management.

Wyoming Highway Department
- 1976 *Wyoming Traffic*. Published in cooperation with the U.S. Department of Transportation, Federal Highway Administration. Cheyenne, Wyoming.
- 1977 *Railroad Crossing Study*. Cheyenne, Wyoming.

Wyoming Recreation Commission 1975. *An Outdoor Recreation Plan for Wyoming*. Cheyenne, Wyoming.

Wyoming State Engineer
1971 *Water and Related Land Resources of the Platte River Basin, Wyoming*. Wyoming Water Planning Report No. 9. Cheyenne, Wyoming.
1972 *Water and Related Land Resources of Northeastern Wyoming*. Wyoming Water Planning Report No. 10. Cheyenne, Wyoming.
1973 *The Wyoming Framework Water Plan*. Cheyenne, Wyoming.
1974 *A Water Development Program for Wyoming*. Wyoming Water Planning Program. Cheyenne, Wyoming.
1975 *Wyoming Water and Irrigation Laws*. Cheyenne, Wyoming.
1976 *Investigations of Recharge to Ground Water Reservoirs of Northeastern Wyoming (Powder River Basin)*. Sponsored by the Old West Regional Commission. Cheyenne, Wyoming.

Zeimens, George M.; Larson, Thomas K.; Longenecker, Julie; and Craig, Cary 1978. Summary of Archeological Investigations for the Buckskin Coal Mine, Campbell County, Wyoming. Prepared for Shell Oil Company.

Zeimens, George M., and Walker, Danny N., eds. 1977. *Archeology of the Eastern Powder River Basin, Wyoming*. Prepared for the Bureau of Land Management. Laramie, Wyoming: University of Wyoming.

PROPOSED

BUCKSKIN

PROJECT

CHAPTER 1

DESCRIPTION OF THE PROPOSED ACTION

INTRODUCTION

The subject of this part of the environmental statement is the proposed Buckskin surface mining project. This site-specific document contains a description of the proposed action, a description of the existing environment, an analysis of impacts associated with the proposed action, and an analysis of alternatives to that action.

HISTORY AND BACKGROUND

The Buckskin Mine would occupy federal coal lease, Wyoming 0325878. The lease was issued to Farmers Union Central Exchange on November 1, 1967, and was subsequently purchased by Shell Oil Company. Approval of the lease assignment was granted effective May 1, 1975. By approving these lease actions, the United States committed 84 million tons of coal reserves to mining. On May 4, 1977, Shell submitted an application to the Wyoming Department of Environmental Quality (DEQ) for a permit to mine.

In May 1977, Shell Oil Company submitted a mining and reclamation plan for the Buckskin project to the office of the Area Mining Supervisor, Geological Survey (GS), Billings, Montana, in accordance with 30 CFR 211 regulations promulgated in May 1976. This plan was accepted by GS as meeting 30 CFR 211 requirements.

In November 1978, Shell Oil Company submitted a revised mining and reclamation plan to the Office of Surface Mining (OSM) and the Wyoming Department of Environmental Quality. The revised plan reflects Shell's interpretation of all applicable federal and state regulations, including those promulgated between May 1977 and September 1978. It also reflects Shell's contractual obligations to a second customer, which necessitate an increased coal production rate.

The revised mining and reclamation plan has not been considered in analyzing impacts of the proposed action for the final environmental statement. An analysis of changes in environmental impacts caused by mine plan modifications will be made after the revised plan has been accepted by OSM as meeting requirements of the State and the Surface Mining Control and Reclamation Act. The revised mine plan is currently being reviewed by OSM (with consultation with GS and BLM) to see if it is acceptable for consideration as a legal mine plan.

SURFACE MINING CONTROL AND RECLAMATION ACT

The mining and reclamation plan evaluated in this environmental statement (ES) was submitted for review prior to promulgation of the initial regulations (30 CFR 700) required under Sections 502 and 523 of the Surface Mining Control and Reclamation Act (SMCRA) of 1977 (PL 95-87), and has not been officially reviewed for compliance therewith. Therefore, the applicant's plan may not fully reflect the requirements of the initial regulations. However, it is believed that the plan presents sufficient data to allow analysis of the impacts associated with mining.

As required prior to approval by the Department of the Interior, the mining and reclamation plan must be returned to the operator for revision in accordance with the applicable regulations. As noted above, the applicant submitted a revised mining and reclamation plan in November 1978. The revised plan is being evaluated by the Office of Surface Mining (OSM) to insure compliance with the provisions of 30 CFR 700 and other federal and state regulations. The revised mining and reclamation plan cannot be approved until it conforms to all applicable federal requirements. After acceptance of the modified plan by OSM, any changes in environmental impacts caused by the modifications will be assessed.

In this ES, the initial regulations pertaining to SMCRA are considered as federal requirements similar to other applicable regulations. The regional analysis, Chapter 3, Planning and Environmental Controls, describes applicable provisions of SMCRA. Regulations pursuant to SMCRA which are cited below were published in final form in December 1977.

PROPOSED ACTION

Purpose and Objective

The federal authorization considered in this part of the environmental statement (ES) is the approval of the mining and reclamation plan for Shell Oil Company's proposed Buckskin Mine. The plan cannot be approved until it has been modified to meet all applicable federal requirements. The purpose of the proposed action is to allow recovery of 80 million tons of low-sulfur, subbituminous coal over a 20-year period. Note that only 80 million tons of the 84 million tons of reserves would be

extracted, partly because current mining technology does not permit the economic separation of the remainder from overburden and partings, and partly because some coal would be left in the lease boundary highwalls. The objective is to supply part of the national energy need, specifically an average of 4 million tons of coal per year. However, if demand increases, the mine could produce more than the 4 million tons per year average. As of May 1977, 18 million tons of coal reserves were committed to Western Farmers, a Rural Electrification Administration cooperative, in Anadarko, Oklahoma; the remainder of the reserves was not committed to a particular consumer.

The description of the proposed action which follows is based on Shell's mining and reclamation plan, as well as personal communications from the company.

Location and Site Description

The 600-acre lease area is roughly 1 mile wide by 1 mile long and is located about 10 miles north of the town of Gillette, in Campbell County, Wyoming. The legal description of the lease area is as follows:

T. 52 N., R. 72 W., 6th P.M., Section 32, S½N½, S½
T. 51 N., R. 72 W., 6th P.M., Section 5, Lots 1, 3, 4

Shell Oil Company owns the surface of the land contained in the mineral lease.

Carter Oil Company, which owns the surface of the lands surrounding the lease, has granted the right of encroachment to Shell upon Lot 2, Section 5, T. 51 N., R. 72 W., 6th P.M., and upon a 1,000-foot corridor around the entire perimeter of the lease area for mine-related activities. This encroachment has been granted for reduction of the highwall and for construction of mine haul roads, ditches, and water diversions. Shell is negotiating separate agreements with Carter for access road and railroad rights-of-way. The lease area and surrounding encroachment area constitute the permit area, which totals 1,760 acres.

Figure BU1-1 shows the proposed Buckskin Mine in relation to other coal mines in Campbell County, and Figure BU1-2 shows the Buckskin project location. Figure BU1-3 shows the coal ownership in the immediate area of the project, and Figure BU1-4 shows the surface ownership.

Mining Method

Shell proposes to use the open-pit, haulback method of surface mining, utilizing the truck and shovel technique (Figure BU1-5).

Employment

During the construction phase, Shell estimates maximum employment at 262. When Buckskin Mine reaches full operation, employment would be approximately 125. Shell Oil Company has been discussing the housing situation in Gillette with the local planning commission and plans to provide housing facilities for their construction employees near the mine site.

Surface Facilities

Construction of surface facilities would begin in 1979 and take 2 years. Offices, shops, parking areas, electrical substation, and water treatment plants would be located in the southeast corner of the lease area. Coal-handling equipment and the railroad loop would be located near the middle of the east edge of the lease. Coal-handling equipment would include a truck dump; a single-stage crushing unit; a belt conveyor to storage; a 50,000-ton-capacity, covered bunker storage facility; a load-out belt conveyor; a sampling tower; and load-out bins.

Surface facilities would occupy approximately 140 acres, beneath which no surface minable coal occurs.

Support Developments

Support developments consist of access and haul roads, railroad spur, power lines, and water supply and sewage treatment facilities.

Roads

Access to the mine site would be via a new road from U.S. Highway 14/16 to the southeast corner of the lease (Figure BU1-6). The road would be 2 miles long, and improved. Construction would begin in 1979. The road would require a right-of-way of 100 feet on each side of the centerline. Cuts, fills, and borrow areas would be needed, but the road would be completely reclaimed at the end of the mine life, unless the current surface owner requests otherwise. Natural drainage along the access road would be maintained by metal culverts and appropriate erosion control structures.

The roads built for the purpose of hauling coal and overburden would be 100 feet wide to allow two-way passage of haul trucks. Scoria (clinker) exposed during removal of overburden and/or purchased locally would be used in the construction and surfacing of the haul roads. Haul roads would be traversed by water trucks as often as necessary (at least twice a day) to minimize fugitive dust. Roads would be maintained (graded) as required by weather conditions. All roads would have culverts where they cross major drainage channels; drainage ditches would be constructed along the sides of the roads. Haul roads would be removed and reclaimed as mining progresses. About 40 acres of roads would be off the areas to be disturbed by actual mining, and these would be reclaimed at the end of mine life. Roads would be designed in conformance with 30 CFR 715-17(l); these Office of Surface Mining (OSM) regulations require a road design which minimizes the impact of roads upon streamflow or runoff of the area.

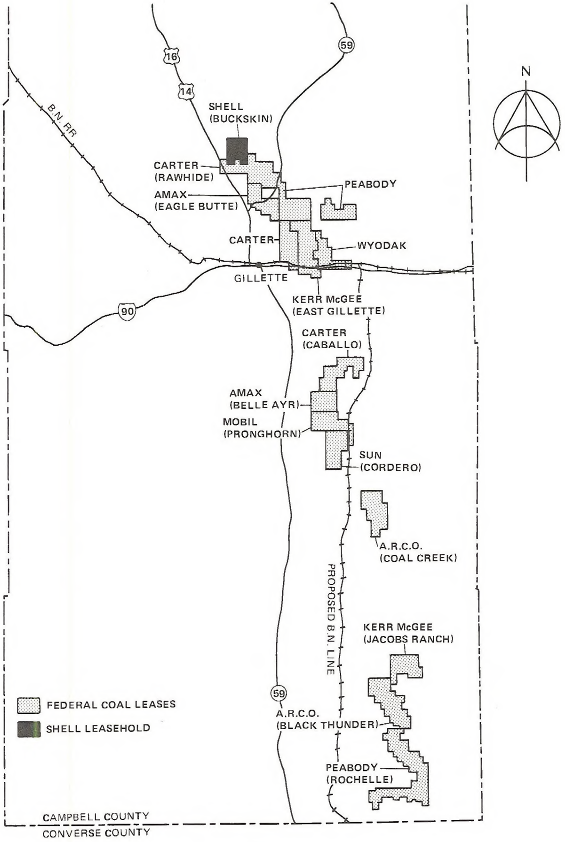

Figure BU1-1
LOCATIONS OF EXISTING MINES OR MINES PENDING APPROVAL ON FEDERAL COAL LEASES IN CAMPBELL COUNTY, WYOMING

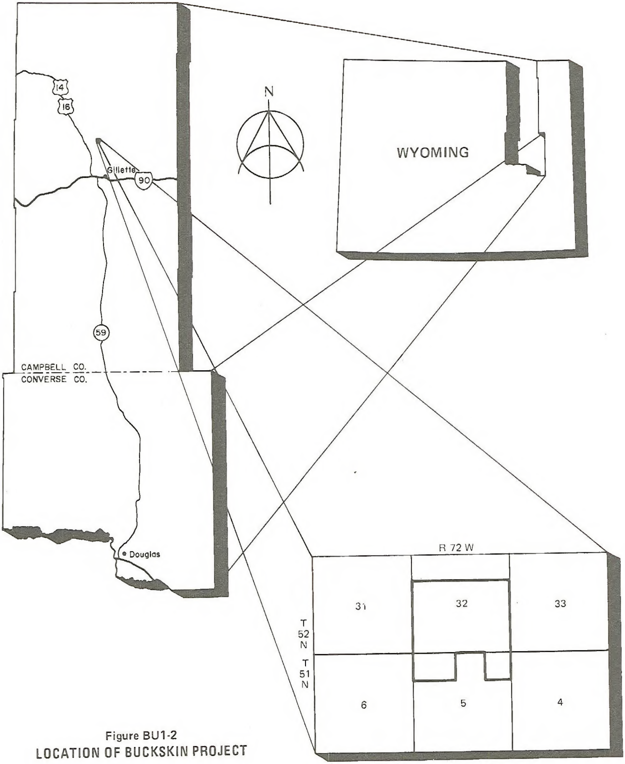

Figure BU1-2
LOCATION OF BUCKSKIN PROJECT

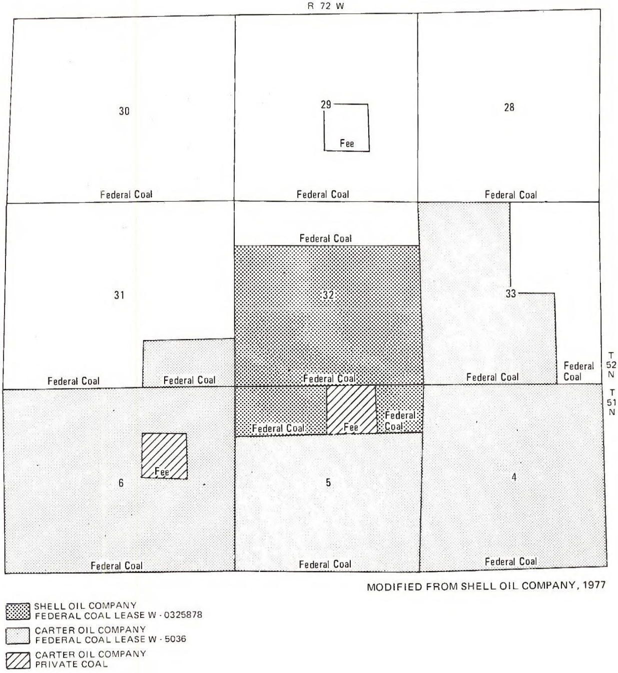

Figure BU1-3

COAL OWNERSHIP IN THE VICINITY OF THE BUCKSKIN PROJECT

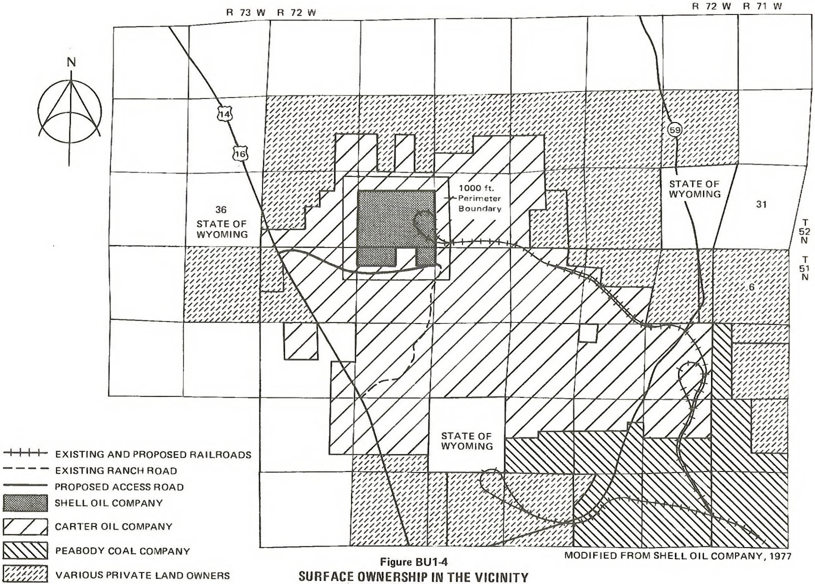

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Figure BU1-4
SURFACE OWNERSHIP IN THE VICINITY OF THE BUCKSKIN PROJECT

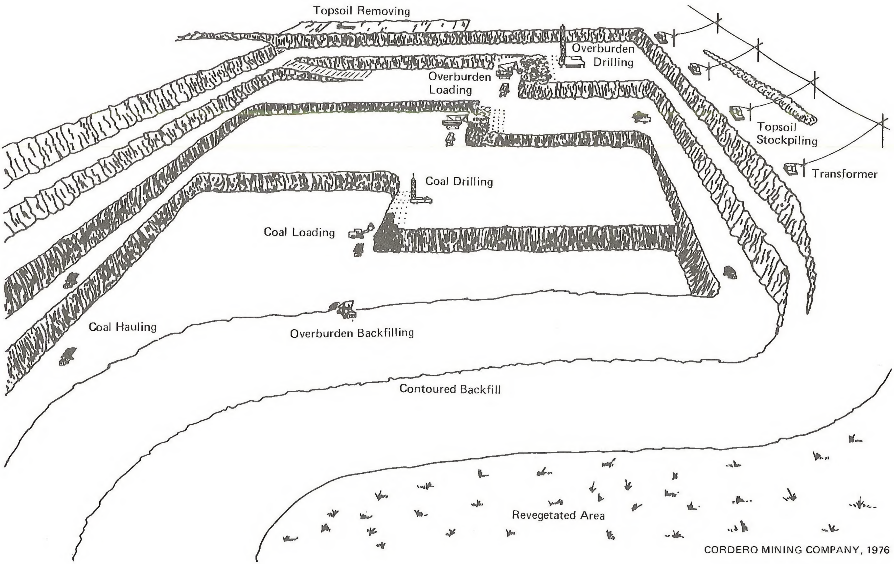

Figure BU1-5
OPEN–PIT, TRUCK AND SHOVEL MINING TECHNIQUE

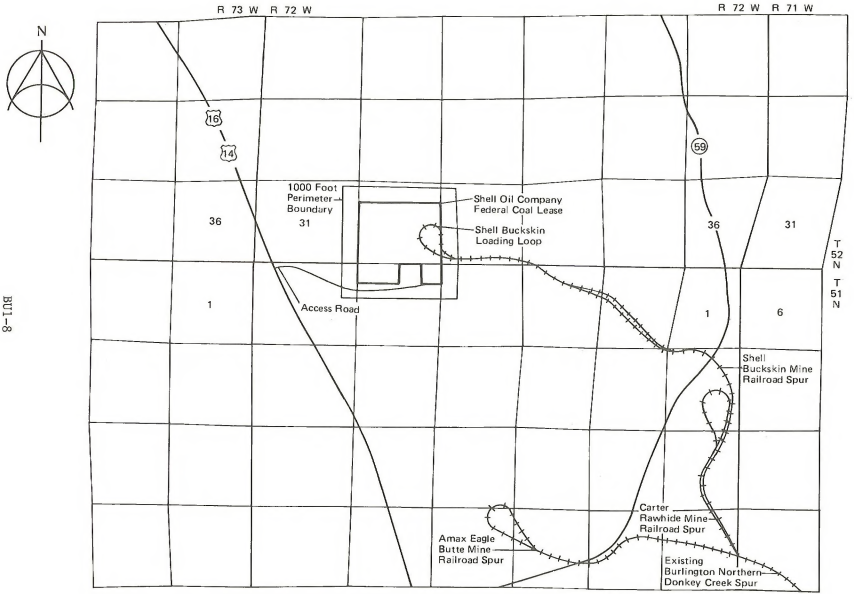

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Figure BU1-6

ACCESS ROAD AND RAILROAD SERVING BUCKSKIN PROJECT

Railroad Spur

As shown in Figure BU1-6, a 6-mile railroad spur and loop would be constructed for the Buckskin Mine. The spur would connect with the Burlington Northern North Gillette line and thence to the existing Burlington Northern main line at a point east of Gillette. The Buckskin spur would require a 100-foot right-of-way. Construction would begin in 1979. If any part of the spur is required for other coal mines in the vicinity after Buckskin is mined out, that part would be left intact. Otherwise the railroad would be removed, and the right-of-way reclaimed. There is a very small quantity of minable coal under the railroad right-of-way; if the coal lessee (Carter Oil Company) wishes to mine this coal while the railroad spur is in place, Shell Oil would move the spur to accommodate Carter's mining operation.

Power Lines

An existing 69-kv power line terminates near the loadout loop of the Carter Oil Company railroad spur. Shell proposes to extend the power line along the 100-foot railroad right-of-way, staying within its confines insofar as practical, to a new terminal point in the Buckskin Mine facilities area. The location of the substation is shown in Figure BU1-7. The overhead power line would be built to accepted engineering standards, including provisions for raptor protection. Power would probably be supplied by Tri-County Electric Association, Inc.

Water Supply and Sewage Treatment

The mine dewatering operation (average 300 gallons per minute (gpm)) is expected to supply about 432,000 gallons per day (gpd), a sufficient quantity for the mining and reclamation operations. Dust suppression on the haul roads would require about 40,000 gpd to be supplied by the mine inflow. Any mine inflow not required would be pumped from settling ponds into Rawhide Creek, probably just above the point where the diversion ditch enters the Rawhide Creek channel (Figure BU1-7). Potable water would be supplied from a well (most likely in the Fort Union Formation) at the location shown in Figure BU1-7. It is estimated that this well would supply about 4,655 gpd, enough for the estimated daily consumption of 125 employees for all uses. In addition, the fire protection system is anticipated to require 400,000 gallons of water, to be obtained from the same well, or perhaps a deeper well in the Lance Formation and Fox Hills Sandstone. Approximately 55,000 gpd of plant water (from the fire suppression well) would be required for cleaning mobile equipment and for dust suppression and cleaning of the coal crusher and loading equipment.

A waste water treatment plant and sewage lagoon system would be installed in the facilities area. The system would be designed to cope with waste water from employees, shop, and miscellaneous uses. The sewage lagoons are designed to store water to cope with a 120- to 150-day freeze-up. All waste water would be channeled through the system and would be suitable for discharge into the existing surface drainage. A surface water monitoring plan would be designed in conformance with 30 CFR 715.17(b) and submitted to DEQ for approval. Data gathered under such a plan must adequately describe total discharge, water quality (chemical parameters and concentrations), and discharge from disturbed areas.

Mining Sequence

The sequence of mining would be as shown in Figure BU1-8. Each block represents approximately 1 year of mining. The company has chosen this layout and sequence to provide for blending of areas of high-sulfur coal (located in a pocket close to the facilities area) with areas of low-sulfur coal, so that when the coal is burned by Shell's customer(s), plant emissions will meet Environmental Protection Agency standards.

Due to varying coal quality, it would be necessary to keep at least a 2-month (0.7 million-ton) supply of coal completely exposed by removing overburden ahead of the active mining operations. This pit inventory would serve a twofold purpose: it would allow blending of the coal and would provide a safety margin against inclement weather.

The acreage disturbed each year would vary, but after the first 3 years when 500 acres would be disturbed (including facilities construction), mining would average 30 acres per year. The total acreage disturbed on the permit area and for the access road and railroad spur would be 1,071 acres (Table BU1-1).

Coal Deposit

The coal to be mined is from the Anderson and Canyon seams, which are approximately 40 and 64 feet thick respectively, as shown in Figure BU1-9. The Anderson overlies the Canyon, and both beds dip to the west and northwest at about 1 degree. They are separated by a shale parting which averages 3 feet in thickness. The overburden varies in depth from less than 20 feet to over 215 feet, averaging 101 feet (Figure BU1-10), and consists of sandstone, siltstone, clay, and shale sediments of the Fort Union Formation. The coal underlying this lease is a part of the Powder River Coal Field. The total extent of coal resources in the region is discussed in the regional analysis, Chapter 2, Mineral Resources.

The average run-of-mine quality of the coal deposit is as follows: ash—6.11%, BTUs—8,183 BTUs per pound, moisture--29.80%, sulfur—0.51%.

The coal is ranked as subbituminous.

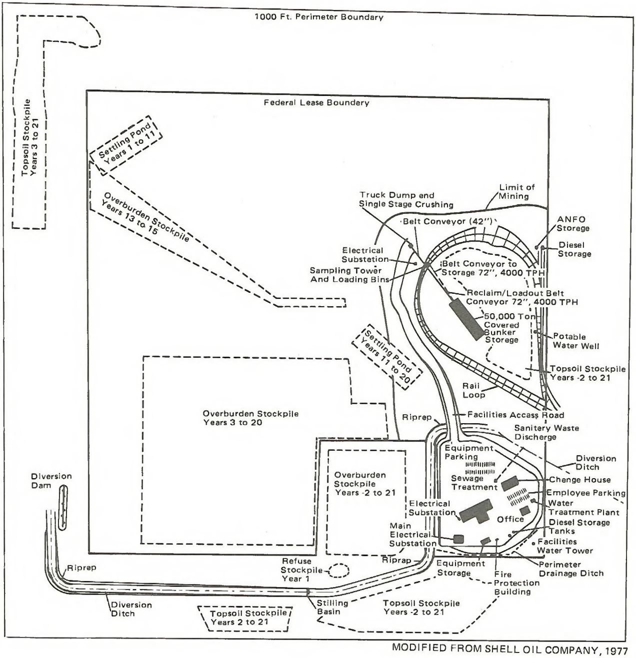

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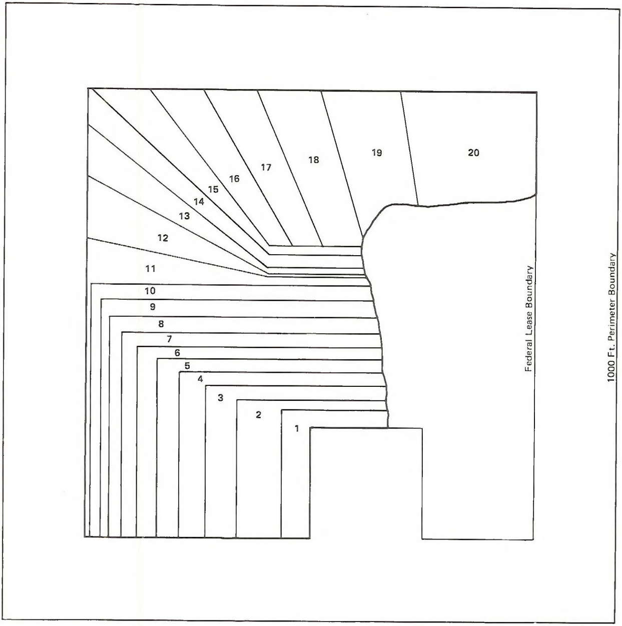
Figure BU1-7
RAIL LOOP AND FACILITIES LAYOUT



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NOTE: Numbers represent years of mine operation

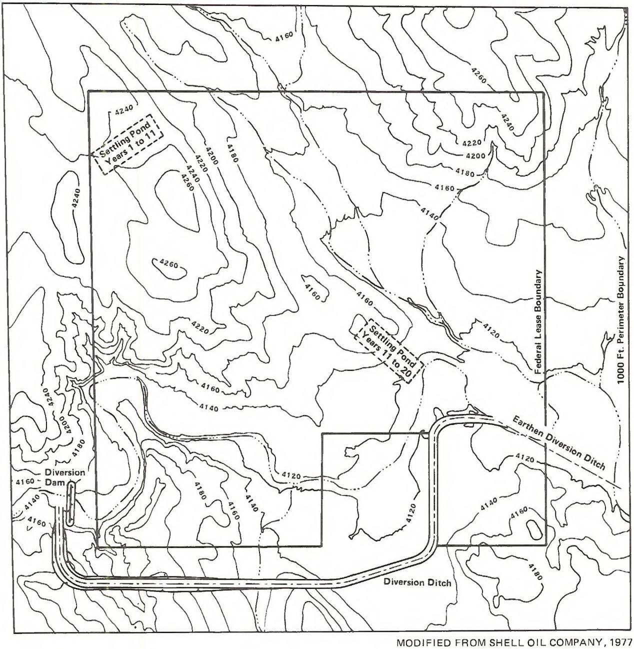
Figure BU1-8
MINING SEQUENCE

TABLE BU1-1

CUMULATIVE ACREAGE DISTURBED BY BUCKSKIN PROJECT

Through Year	Acres Disturbed
1980	434
1985	670
1990	790
1990 to 2001	1,071

Source: Shell Oil Company 1977



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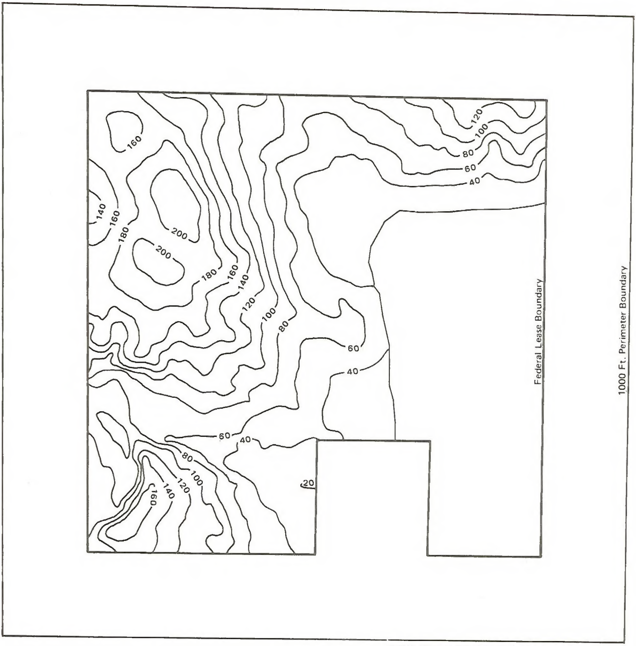
NOTE: Contour interval 20 feet
Elevation in feet above sea level

Figure BU1-11
SETTLING PONDS AND DIVERSION DITCHES



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NOTE: Thickness Measured In Feet

Figure BU1-10
OVERBURDEN THICKNESS MAP

Mining and Process Procedures

Topsoil Removal

Mining plans call for the salvage of all available topsoil ahead of the overburden and coal removal processes. Likewise, prior to the construction of mine buildings, roads, railroads, access roads, diversion channels, and settling ponds, all topsoil which has been determined by analysis to be suitable for reclamation purposes would be salvaged and stockpiled, or immediately spread on areas being reclaimed. (After the initial years of mine operation, it is anticipated that most salvaged topsoil could be spread immediately or during the same year as salvage.) Figure BU1-7 shows the locations and relative sizes of the topsoil stockpiles. Stockpiles would be marked to prevent accidental mixing with overburden, and seeded and mulched to prevent erosion.

A scraper would be used to load, transport, and place the topsoil, except where the removal depths are such that front-end loaders might be used advantageously to load haul trucks for this operation. Shell anticipates that approximately 1,414 bank cubic yards (1,944 tons) of topsoil would be moved per day. Topsoil handling would be done in conformance with 30 CFR 715.16, which delineates methods to remove, segregate, analyze, store, and replace topsoil.

Overburden Removal

The overburden would be removed with a large mining shovel after blasting where necessary. The overburden would be removed in benches with heights ranging from about 40 to 60 feet, and widths averaging 90 feet for benches used as two-way haul roads, or 50 feet for benches not commonly used as haul roads.

The overburden would be loaded into haul trucks and placed in stockpiles or on the advancing spoil bench, where it would be dozed over the edge of the bench into the mined-out pit. This latter operation would provide a spoil surface at or near the elevation of the final reclaimed topography, necessitating only minor grading prior to topsoil replacement.

Overburden material which cannot be immediately replaced in mined-out areas, such as that removed during the opening of the box cut or needed for replacement in the final pit, would be stockpiled. Locations and relative sizes of the overburden stockpiles are shown in Figure BU1-7. Stockpiles would be marked to prevent accidental mixing with topsoil, and seeded and mulched to prevent erosion. Overburden disposal sites would be designed to meet OSM standards set in 30 CFR 715.15, which outlines design criteria for disposal of spoil and waste materials in areas other than the mine workings and excavations.

Overburden removal would require shifting approximately 25,870 tons of material per day, using four 120-ton-capacity haul trucks per shift.

Coal Mining, Loading, and Hauling

The coal would be mined from benches ranging from 30 to 60 feet high, and 90 feet wide for benches used as two-way roads, or 50 feet wide for benches not commonly used as haul roads. Due to the dip of the deposit and the varying coal thickness, bench height would increase as the working face advances, necessitating mining in additional benches. Overall highwall slopes would range from 1:0.4 to 1:0.6.

The coal would be loosened by drilling and shooting with (most probably) an ammonium nitrate-fuel oil (ANFO) type explosive. The blasted or "shot"coal would be loaded into haul trucks by mining shovels or large front-end loaders. Three 85-ton-capacity haul trucks per shift would transport the coal up ramps and along benches to the crusher site or stockpile area.

Coal Handling

Coal would be dumped from the trucks into the single-stage crushing unit and crushed to 2-inch size. From here it would be transported by a 72-inch belt conveyor to a 50,000-ton-capacity, covered bunker storage facility. In case of equipment breakdown, either crushed or mine-run coal may be stored in an active surge stockpile in the area of the coal-handling facilities. The surge pile would seldom exceed 6,000 tons or be in place more than 24 hours.

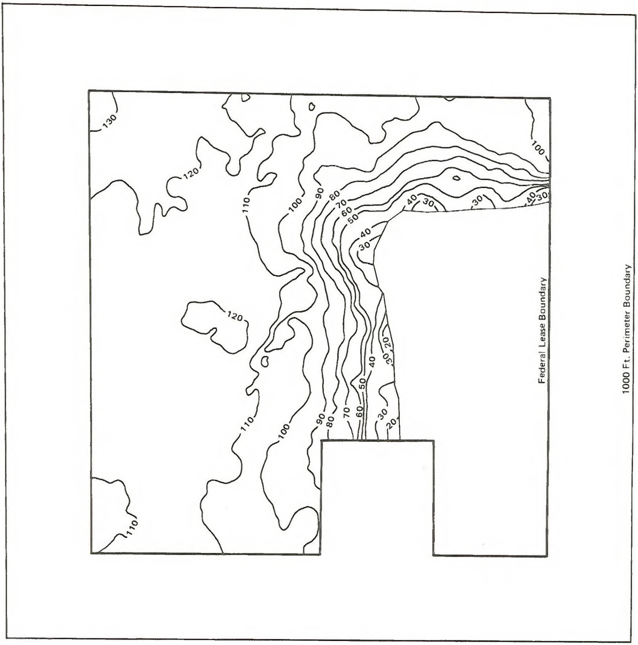
From the bunker, the coal would be conveyed to the sampling tower and load-out bins and loaded into rail cars. The coal would be transported by unit train to markets in Oklahoma. The unit trains would consist of 100 to 120 cars of 100-ton capacity each. The number of unit trains required would depend on coal production rates. With production at 4 million tons per year, unit train frequency would be approximately eight per week. The rail cars would be weighed before leaving the facilities area to measure the amount of coal shipped.

Watercourse Diversions

The mining sequence would require the diversion of the intermittent stream, Rawhide Creek. Temporary diversion would be accomplished by use of a 7,500-foot-long, 65-foot-wide, and 12-foot-deep channel around the south boundary of the lease area (Figure BU1-11). After completion of mining and reclamation, Rawhide Creek would be returned to approximately its original (present) location.

The location of the proposed rail loop precludes use of the existing channel in a section of Rawhide Creek downstream from the diversion channel and near the eastern boundary of the lease area. Therefore, an earthen ditch bypass would be constructed as shown in Figure BU1-7.

Both of these diversion channels would have channel beds on essentially flat slopes and grass-lined banks; they have been designed to carry a 20-year flood at a velocity of 2 feet per second. (The flood-capacity design has not been approved. See Chapter 4.) In no case would overburden or topsoil be pushed into, or placed below, the flood level of Rawhide Creek except during the construction of the diversion. Rock riprap, concrete, soil cement, or other suitable material would be used to mini-



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NOTE: Thickness Measured In Feet

Figure BU1-9
COAL THICKNESS MAP

mize erosion and degradation of water quality. The anticipated locations of several of these protective devices are shown in Figure BU1-7.

The watershed and flow of Spring Draw are small, and therefore large runoffs are not expected. Any flow would be diverted around the active operation in temporary ditches, which would be moved as mining progresses. The diverted water would be discharged along existing drainageways and allowed to flow into Rawhide Creek.

Overland flow would be diverted away from the active mining operation, newly reclaimed areas, and stockpile areas by temporary diversion ditches. Ditches in existence longer than 1 year would be grass lined.

Surface water diversions would meet standards set in 30 CFR 715.17(a), which deal with the quality and monitoring of water discharged.

Underground water resources are present in the area, as they are throughout most of the region. Mining would disrupt the existing shallow aquifer, which is the overlying sandstone and the coal itself. Mine inflow during the operation would average 300 gpm. Groundwater would be protected by pumping mine inflow from the pit and discharging the water (after treatment, if necessary) into the surface water system; this would prevent the addition of dissolved and suspended solids into the groundwater, which might occur if the mine inflow were pumped directly back into the groundwater system.

Settling ponds would be utilized for removal of particulates in the water, as well as for sewage treatment. The ponds would be removed during the course of mining or at the completion of mining activities. The locations of these settling ponds are shown in Figure BU1-11.

Groundwater monitoring in wells is currently being done and would continue throughout the mine life to assess any changes resulting from the mining operation. Figure BU2-8 shows the location of monitor wells on the lease. Undesirable changes are not expected, but if they occur, the appropriate authorities would be notified as required by law, and corrective measures would be taken.

Reclamation Activity

The annual reclamation diagram (Figure BU1-12) and Table BU1-2 show the reclamation sequence and schedule.

All reclamation activity at the proposed Buckskin Mine must conform to the stipulations and requirements of the federal coal lease involved, the requirements of the Wyoming State Environmental Quality Act of 1973, and other applicable federal, state, and local regulations and laws. Compliance with these laws would be enforced through regular inspections by federal and state officials.

Present and Future Land Use

Grazing by livestock and wildlife is the major current land use of the proposed mine area. Some small areas along Rawhide Creek are used for hay production. A cultivated field (wheat and barley) at the southern edge of the permit area would be disturbed during construction of the water diversion structures. (This has been determined to be not prime farmland.) There are no active oil or gas wells on the permit area or adjacent lands.

Shell proposes to reclaim the disturbed land primarily for grazing use, although the change in use of the cultivated fields has not been approved. Due to the relatively gentle slopes in the area following mining, portions of the land could be used for hay production. Some areas of the lease would also be planted with shrubs and/or trees for wildlife use. This proposal conforms with the State of Wyoming's regulations.

Shaping of Overburden (Backfilling)

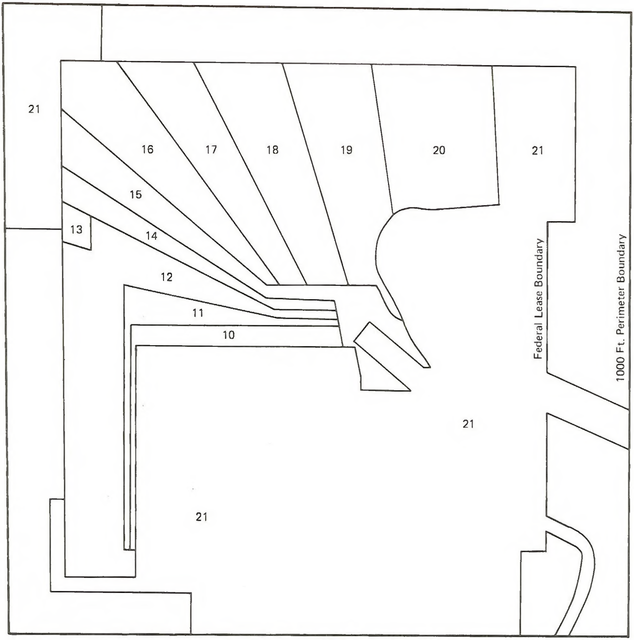
The faces of the overburden and coal bed in the highwall of the final pit would be reduced by blasting. The overburden and coal would be drilled and blasted in accordance with 30 CFR 715.19 regulations concerning use of explosives. The final pit area would be backfilled, graded, and contoured to blend with the surrounding topography and to provide drainage. The postmining topography would have slopes ranging from .5% to 31%, with an average slope of 4.7%; a maximum slope of 31% (17 degrees) would occur at the mineral lease boundaries where the highwalls are blended with the existing topography. (The premining slopes range from 1% to 31%, with an average slope of 7.5%.) Reclaimed highwall slopes greater than the average natural slope (31% vs. 7.5%) might be necessary in order to minimize the amount of affected lands; the use of reclaimed highwall slopes of 7.5% maximum could result in as much as a 125% increase in the amount of the disturbed lands in the area of highwall reduction.

Final shaping of the overburden would be done prior to the placement of topsoil, and would normally occur during the period when seeding of the permanent cover is impractical (usually August 1 through October 31). Backfilling and grading would be done in conformance with 30 CFR 715.14 regulations. These regulations set forth criteria for all backfilling and grading necessary, including slopes, depressions, gullies, overburden conditions, and stabilization.

Placement of Topsoil

Soils tested and found unsuitable for plant growth would be treated as overburden. However, Shell estimates there is enough suitable topsoil available to replace a minimum depth of 18 inches on all disturbed areas.

Topsoil would be obtained from either the stockpiles or the ongoing salvage operation. To the extent practicable, topsoil would be applied at right angles to the slope and left in a rough condition until shortly before the actual seeding is accomplished. This would provide protection against wind and water erosion and increase the accumulation of moisture. Where the shaped spoil material is relatively level, the topsoil would be applied in a



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NOTE: Numbers represent years of mine operation

Figure BU1-12
RECLAMATION SEQUENCE

TABLE BU1-2

RECLAMATION SCHEDULE

Year	Acres Disturbed	Cumulative Acres Disturbed	Acres Reclaimed	Cumulative Acres Reclaimed	Acres Undisturbed	Disturbed Acres Unreclaimed
- 2	362	362	-	-	709	362
- 1	72	434	-	-	637	434
1	23	457	-	-	614	457
2	78	535	-	-	536	535
3	76	611	-	-	460	611
4	44	655	-	-	416	655
5	15	670	-	-	401	670
6	28	698	-	-	373	698
7	34	732	-	-	339	732
8	25	757	-	-	314	757
9	17	774	-	-	297	774
10	16	790	14	14	281	776
11	24	814	23	37	257	777
12	39	853	65	102	218	751
13	21	874	7	109	197	765
14	13	887	32	141	184	746
15	22	909	40	181	162	728
16	15	924	31	212	147	712
17	18	942	31	243	129	699
18	25	967	37	280	104	687
19	51	1,018	70	350	53	668
20	40	1,058	55	405	13	653
21	13	1,071	666	1,071	-	-
TOTAL	1,071		1,071			

Source: Shell Oil Company 1977

north-south direction to control wind erosion. Topsoil placement and handling would be conducted according to 30 CFR 715.16 regulations.

To prevent creation of a cloddy structure, topsoil would not be salvaged or redistributed when it is excessively wet or frozen. When it is possible, topsoil salvage and redistribution would take place immediately prior to the planting seasons (fall and spring). If it is necessary to place topsoil at other times, it would be seeded with quick-growing annuals (such as oats or barley) to minimize erosion and to contribute a dead mulch into which the permanent species would be seeded later.

Revegetation Plan

Shell's revegetation plan was developed primarily to support domestic livestock grazing; this plan must be reviewed for compliance with 30 CFR 715.13 regulations, which require the restoration of lands affected to a condition capable of supporting the uses which existed prior to mining, or higher or better uses of which there is reasonable likelihood. Note that the impact analysis in Chapter 3, Soils, disputes Shell's statement that 100% of premining productivity can be restored. A permanent vegetative cover of predominantly native grass species, which are perennial, self-renewing, and adapted to the climate of the region, would be reestablished on all lands disturbed by mining or for surface or support facilities. Although the seed mixture and seeding techniques may be adapted to meet the requirements of the Wyoming Department of Environmental Quality (DEQ), Land Quality Division, Shell proposes to use the mixtures and rates shown in Table BU1-3. DEQ has recommended against the use of *Caragana*, but the final seed mixture has not been determined. In areas where wildlife habitat is to be provided, native trees and shrubs would be hand planted from nursery stock or transplanted from areas being stripped.

Prior to seeding, the topsoil would be ripped to a depth of at least 18 inches to allow root penetration and water retention. Additional shallow ripping may be required to assure a loose, friable soil surface. Seed would be drilled on the contour to a depth of 1 inch in sandy soils and ½ inch in clayey soils. If seed must be broadcast in areas too steep or rocky for drill-seeding equipment, soil material would be hand raked or harrowed over the seed. Topsoil handling and seedbed preparation would be done in conformance with 30 CFR 715.16 and 715.20; the former regulations define topsoil handling procedures so as to minimize degradation and loss, and the latter regulations establish revegetation procedures, timing, methods, and success standards.

Needed fertilizer, as determined by testing of the topsoil, would be applied prior to seeding or after seedling emergence. Annual applications of fertilizer are not planned. Except in abnormally dry years, irrigation of newly planted areas would not be considered (except for the trees and shrubs); Shell would time seeding to take full advantage of natural available moisture (between mid-October and late April). To prevent wind or water erosion and loss of moisture, mulches will be applied to the seeded areas. To accumulate moisture on exposed slopes or for trees and shrubs, snow fences may be constructed. Herbicides would be used according to state and federal regulations to control noxious weeds in newly planted areas. Livestock grazing would be excluded from reclaimed areas for at least 2 years.

Decommissioning and Abandonment

At the end of mine life, all surface facilities would be removed. The land surface involved would be ripped to loosen compaction, spread with a minimum of 24 inches of topsoil, and revegetated.

The railroad spur and access road could be retained, as might some buildings, if requested by the surface owner at the time.

Pollution Control Methods

Methods proposed by Shell to control air pollution from coal dust and blowing soil are as follows:

1. All unsurfaced roads would be watered a minimum of twice a day, and more if necessary.
2. Topsoil and overburden storage piles would be seeded with fast-growing annual and/or perennial species.
3. Coal would be stored in a covered bunker.

Methods proposed by Shell to prevent water pollution from sediment or toxic material are as follows:

1. The bottoms and sides of temporary water diversion structures would be grass lined.
2. Culverts or bridges would be installed to prevent traffic through drainages.
3. Diversion ditches would be designed to discharge away from topsoil and overburden storage areas, and newly reclaimed areas.
4. Riprap or concrete would be used at curves in diversion ditches, if it becomes necessary to prevent erosion.
5. Overburden material determined to be toxic or a health hazard would be buried at the bottom of the mine pit, or well below the root zone, and kept away from stream channels or drainages. It is expected that Shell would be monitoring the overburden characteristics during the mining operation, and would take any necessary steps to deal with any toxic materials discovered.
6. If runoff leaches toxic material from overburden or coal stockpiles, the contaminated water would be impounded and treated prior to release into surface drainage.

Methods proposed by Shell to prevent or control fires are as follows:

1. Coal storage areas would be designed to eliminate fire hazards from spontaneous combustion.
2. A fire protection system is planned for the surface facilities area.

TABLE BU1-3

PROPOSED SEEDING RATES (POUNDS OF PURE LIVE SEED PER ACRE)

Species	Basic Mixture	Heavy Soil Uplands	Heavy Soil Depressions	Sandy Soil	Wildlife Areas	Wet Areas
Agropyron smithii western wheatgrass (Rosana)	3	4	4		2	4
Agropyron dasystachyum thickspike wheatgrass (Critana)	3	3	2	3	2	
Agropyron riparium streambank wheatgrass (Sodar)	3	3	2	3	2	
Onobrychis viciaefolia sainfoin (a legume)			3			
Oryzopsis hymenoides Indian ricegrass				2	1	
Stipa viridula green needlegrass	1	1			1	
Phalaris arundinacea reed canary grass						3
Agropyron elongatum tall wheatgrass (Orbit)						4

TABLE BU1-3
(cont'd)

PROPOSED SEEDING RATES (POUNDS OF PURE LIVE SEED PER ACRE)

Species	Basic Mixture	Heavy Soil Uplands	Heavy Soil Depressions	Sandy Soil	Wildlife Areas	Wet Areas
Astragalus cicer Cicer milkvetch (a legume)						1
Atriplex canescens fourwing saltbush				2	2	
Rosa spp. rose					*	
Caragana pymaea pygmy caragana					*	

Source: Shell Oil Company 1977

Note: Rates of seeding are for drilled stands. If broadcast seeding is necessary, the rate of seeding should be doubled.

* Amount used per acre would depend upon the size and frequency of the spot seeding areas selected.

AUTHORIZING ACTIONS

This section identifies governmental authorizations which would be required to implement the proposed action.

Assistant Secretary of Energy and Minerals

The Assistant Secretary shall approve the mining permit application (including the mining and reclamation plan) and significant modifications or amendments thereto prior to commencement of mining operations by the company.

Office of Surface Mining (OSM)

OSM, with the concurrence of the leasing agency (Bureau of Land Management) and GS, recommends approval or disapproval of the mining and reclamation plan to the Assistant Secretary of Energy and Minerals. Since Wyoming has entered into a state-federal cooperative agreement with the Secretary of the Interior, pursuant to Section 523(c) of the Surface Mining Control and Reclamation Act (SMCRA), the state regulatory authority and OSM will jointly review mining and permit applications. Both agencies will recommend approval or disapproval to the officials of the state and Department of the Interior authorized to take final actions on the permit.

Bureau of Land Management (BLM)

BLM develops special requirements to be included in the reclamation plan concerning management and protection of all resources other than coal and the postmining land use of the affected lands.

Geological Survey (GS)

GS is responsible for development, production, and coal resource recovery requirements included in the mining permit.

State of Wyoming, Department of Environmental Quality (DEQ)

Wyoming entered into a cooperative agreement with the Secretary of the Interior in October 1978, pursuant to Section 523(c) of SMCRA; DEQ and OSM will jointly review and act on the mining and reclamation plan and permits to mine authorized under a federal coal lease.

The Land Quality Division of DEQ issues permits and licenses to mine according to the approved mining and reclamation plan. The Air Quality Division issues permits for construction and operation after review of applications with regard to air contaminants and plans for control and monitoring. The Water Quality Division issues permits to construct water systems. The Solid Waste Division issues construction fill permits and industrial waste facility permits for solid waste disposal during construction and operation.

Wyoming State Engineer

Use of surface or groundwater for mining and coal processing operations requires a permit from the State Engineer. Permits are also necessary prior to installation of wells, the use of mine inflow waters, and construction of water pipelines.

INTERRELATIONSHIPS

Relationship to Land Use Plans

Bureau of Land Management (BLM)

The Management Framework Plan (MFP) for the Eastern Powder River Basin, as updated in 1977, recommends the management of mineral resources for efficient development, giving priority consideration to energy minerals. At the same time, it considers environmental protection and mitigation of socioeconomic impacts.

Planning recommendations specific to the proposed Buckskin Mine were not addressed in the MFP since the coal is under an existing federal lease issued in 1967.

Gillette/Campbell County

The City of Gillette/Campbell County Planning Department, formed in 1968, completed a draft comprehensive plan in 1977. Among other provisions, the plan proposes countywide monitoring of surface coal mining for conformance to the plan, in order to control the rate and location of development in the county. BLM land use planning would consider the recommendations of this plan; however, specific applications of this draft plan have not been made to the proposed Buckskin Mine.

Relationship to Other Proposed and Future Actions

The proposed Buckskin Mine would supply 2% of the 173 million tons of coal to be mined in the region in 1990 under the probable level of development, as discussed in the regional part of this document. The 400 additional unit trains of coal per year would constitute 2.5% of the projected 15,697 unit trains that would leave the region from all mines annually by 1990.

Other active and approved mines in the Gillette area would cause competition for housing, services, and the

available labor supply; would increase rail traffic, dust, and water usage; and would increase the demand on transportation and communication networks.

Reference is made to the analysis included in the regional part of this environmental statement for a full discussion of the interrelationship between the Buckskin Mine and other mines in the region.

CHAPTER 2

DESCRIPTION OF THE ENVIRONMENT

INTRODUCTION

This chapter consists of two parts: existing environment and future environment. It describes the physical, biological, and cultural factors which constitute the environment at the proposed Buckskin Mine site. The description of the existing environment emphasizes those environmental factors most likely to be affected by the proposed action. The description of the future environment focuses on the same environmental factors as they would exist in 1980, 1985, and 1990, and at the end of mine life without approval of the proposed action. These descriptions provide a base for the analysis in Chapter 3, "Environmental Impacts of the Proposed Action,"since alteration of these environmental factors would result if approval were to be granted.

CLIMATE

The climate of Campbell and Converse counties is characterized by dry air masses, which are modified Pacific air masses that move eastward over the Rocky Mountains. The Big Horn Mountains, part of the Rocky Mountain chain, lie about 60 miles west of the proposed Buckskin Mine site. Most of the region's precipitation falls from these air masses, but some precipitation results from incursions of moist air from the Gulf of Mexico. In the summer, most of the precipitation in the region is provided by thunderstorms. The prevailing winds are south-southeasterly and south-southwesterly. Northerly winds are also common.

The proposed Buckskin Mine site, about 10 miles north of Gillette, is located in an area of gently rolling hills. Temperatures at the site average 44°F annually with an average of 22°F in January and 72°F in July. Maximum temperatures of 90°F or above occur in July, while January is the coldest month with a frequent daily mininum temperature of 0°F or below. The average growing season (32°F or above) at the site is estimated to be 129 days. The area receives about 14 inches of precipitation annually (National Oceanic and Atmospheric Administration 1974).

Theoretical calculations indicate that at any point in the Eastern Powder River Basin the mean recurrence interval for a rainfall rate of 1.7 inches in a 30-minute period is 100 years. Similarly, 24-hour rainfalls of 4 inches can be expected once every 100 years (Hershfield 1961). It may be assumed that these occurrences have the same probability at the Buckskin Mine site.

Statistical analysis of long-term data for Douglas, Gillette, and Dull Center indicates that 1-year drought periods occur once every 7 years; 2-year drought periods occur once every 25 years; and 3-year drought periods occur once every 143 years. For further details, refer to Chapter 2, Climate, in the regional analysis.

Wind speeds are out of the south for much of the year and average about 9 miles per hour. Figure BU2-1, a wind rose for Moorcroft, Wyoming, is considered representative of wind patterns on the Buckskin site. Stable atmospheric conditions prevail about 60% of the time because of the cool temperatures and moderately strong winds (Hosler 1961). Surface-based inversions occur on 75% of the mornings, being most frequent in summer (84%) and least in winter (60%). They occur only 18% of the time in the afternoon, being most frequent in winter (41%) and least in spring (5%). The mean annual lake evaporation is about 36 to 42 inches.

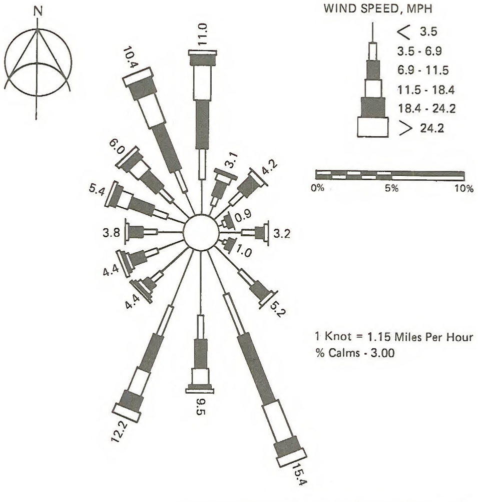
AIR QUALITY

Particulate air quality in undeveloped areas of Campbell and Converse counties ranges from 11 to 31 micrograms per cubic meter ($\mu g/m^3$) annual geometric mean as recorded at 17 state and privately operated particulate sampling sites. The median concentration at the 17 samplers is 19 $\mu g/m^3$.

The available particulate sampling data which best represent existing particulate air quality at the proposed mine site are from two high-volume samplers which were located onsite. The annual geometric mean concentrations recorded at the sampling sites were 11 and 12 $\mu g/m^3$, with maximum 24-hour concentrations of 44 and 47 $\mu g/m^3$. These values are all less than 20% of the corresponding Wyoming state ambient air quality standard.

Concentrations of sulfur dioxide (SO_2) and nitrogen dioxide (NO_2) were sampled at a site 7 miles south of Gillette. The annual arithmetic means recorded in 1976 for SO_2 and NO_2 were 13 $\mu g/m^3$ and 19 $\mu g/m^3$ respectively (Wyoming Department of Environmental Quality 1977), both of which are far below the Wyoming state standards. No measurements of carbon monoxide or hydrocarbons were taken.

Visibility at the site ranges from less than 1 mile to greater than 60 miles throughout the year. The primary causes of low visibility are fogs, haze, dust, and blowing snow. Average monthly visibility ranges from about 26 to 47 miles, with greatest visibility occurring during spring and summer months.



SOURCE: NATIONAL CLIMATIC CENTER, 1950-1952, 1968

Figure BU2-1
ANNUAL WIND ROSE FOR THE PROPOSED BUCKSKIN MINE SITE

TOPOGRAPHY

The proposed mine site lies within the Upper Missouri Basin of the Northern Great Plains physiographic province (Fenneman 1931); it is characterized by low, rolling hills dissected by intermittent drainages. In the northern part of the site, the land slopes gently southward, and in the southern part gently northward into Rawhide Creek, the main drainage. Rawhide Creek is an intermittent stream which flows from west to east across the southern part of the site. Spring Draw, the main tributary of Rawhide Creek in the lease area, is also intermittent. It flows from northwest to southeast and joins Rawhide Creek along the southeast edge of the lease. Two intermittent internal drainage systems which terminate in playas are present along the western boundary of the lease, and two more are present within the 1,000-foot perimeter (Figure BU2-2). The highest point of elevation on the lease is about 4,260 feet in the northeast corner, and the lowest point, 4,110 feet, is on the southeast boundary where Rawhide Creek exits the property. A physiographic diagram illustrating generalized topography of the lease is shown in Figure BU2-3. Figure BU2-2 is a detailed topographic map of the mine site.

GEOLOGY

The proposed mine site is located on the gently (generally less than 2°) southwest dipping east flank of the Powder River Basin.

Geologic formations that are exposed in the lease area are the Paleocene Fort Union Formation, the Eocene Wasatch Formation, and Quaternary alluvium. (See regional analysis, Figure R2-7, for rock and geologic time sequences.)

There is some disagreement as to the exact location of the Fort Union-Wasatch boundary, but for purposes of this statement, it is considered to be at the top of the coal. The Fort Union Formation, below the coal, consists of brown and dark gray to black carbonaceous shale and siltstone interbedded with light gray, fine-grained, friable sandstone and thin coal beds. The Anderson-Canyon (Wyodak) coal bed, which is to be mined, is at the top of the Fort Union Formation and averages 104 feet in thickness in the lease area. The Wasatch Formation above the coal consists of shale, sandy shale, and soft lenticular sandstone. It varies from 20 to 215 feet in thickness.

Quaternary deposits consist of colluvium (weathered bedrock) and unconsolidated clay, silt, sand, and gravel alluvium along streams. Some of the quaternary units are wholly or partially within the definition of alluvial valley floors (Surface Mining Control and Reclamation Act (SMCRA)) as shown on the geologic map (Figure BU2-4). (Quaternary units not within the SMCRA definition are not shown.) Scoria (clinker) is present in many places in the permit area; scoria is the result of baking and collapse of the enclosing rock when portions of the coal seam burned, probably during early Quaternary (Pleistocene) time. Scoria, colluvium, and alluvium generally mask the outcrop of the coal seam, but the approximate edge of the coal is shown on Figure BU2-4. The line showing the top of the coal in Figure BU2-4 was formed by joining the ends of structure contours on top of the Wyodak Seam (Shell Oil 1977, Figure 2.1-3). The line showing the base of the coal is equivalent to the 0 (zero) thickness line on the coal isopach map (Carter Mining Company 1977, Figure 7, Sheet 2).

According to the environmental analysis provided by the applicant, the area is geologically stable with no faulting or extensive folding, and there is no evidence of landsliding or stratigraphic instability. Geological stability is a regional characteristic.

Paleontology

The proposed Buckskin site was surveyed for paleontological resources and assessed for its potential by Paul O. McGrew, Department of Geology, University of Wyoming, in 1976. He reported the following results (personal communication 1977). No fossil localities are known from the lease area. Fossil leaves and invertebrates which occur fairly abundantly throughout the Fort Union and Wasatch Formations likely would be encountered at the Buckskin site. No significant vertebrate fossils have ever been found in the Fort Union Formation of the Powder River Basin, and vertebrate fossils from the Wasatch Formation are quite rare and known from only a few isolated localities. Some of these forms could be encountered at the Buckskin site. McGrew assessed the possibilities of encountering fossil mammals in the lease area as remote for the Fort Union Formation and very low for the Wasatch Formation.

SOILS

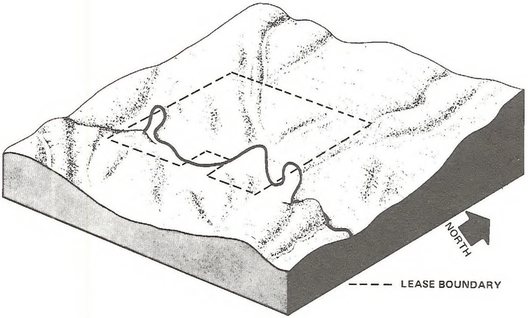
Eight soil series and one land type, rough broken land, have been identified on the Buckskin lease by the Soil Conservation Service (SCS) in their 1955 Soil Survey of Campbell County, Wyoming. These were correlated with the most recent soil survey of the area by Mine Reclamation Consultants of Laramie, Wyoming in 1976 (Shell Oil Company 1977). The soil map (Figure BU2-5) shows the location and extent of different kinds of soil located on the Buckskin lease. The proposed mine site is being remapped by SCS; information given on Figure BU2-5 and below may change as a result of the remapping.

The following are brief descriptions of the soils on the lease area. A technical soil profile description of each soil series is shown in the Appendix. More interpretive information on each soil series below is in Table RB-1, Appendix B of the regional analysis.

Arvada Series: The Arvada series consists of deep, well-drained, fine-textured, alkaline-rich soils forming on level to undulating alluvial fans and topslopes. Topsoil potential is poor because of high clay content and high alkaline content.

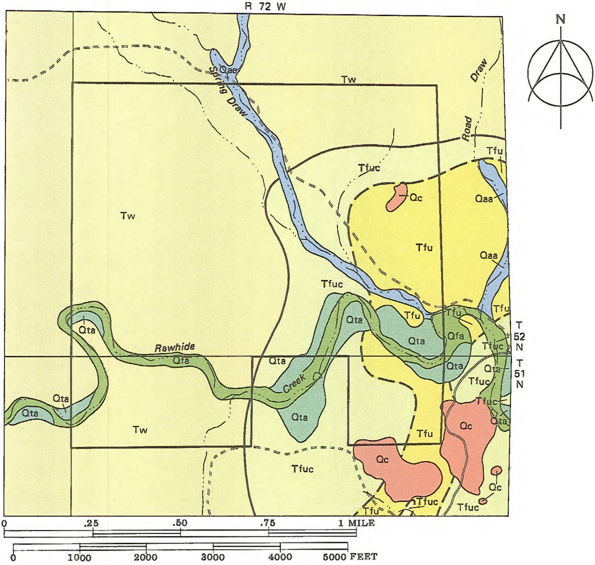
MODIFIED FROM SHELL OIL COMPANY 1977

Figure BU2-2
TOPOGRAPHIC MAP OF THE BUCKSKIN MINE AREA



SOURCE: ECOLOGY CONSULTANTS 1977

Figure BU2-3
GENERALIZED TOPOGRAPHY OF THE PROPOSED BUCKSKIN MINE AREA



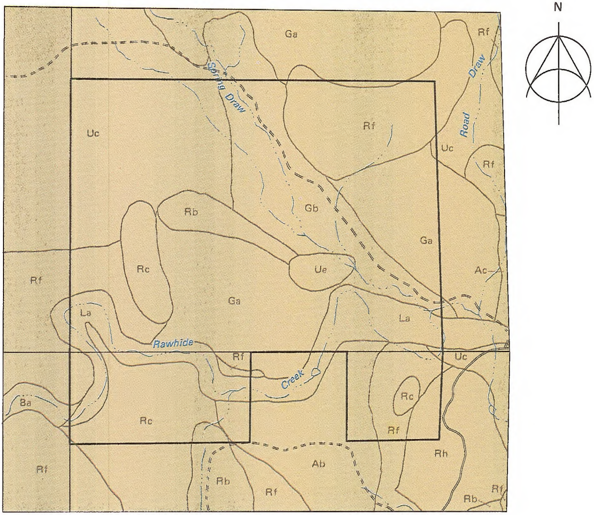
LEGEND

Qfa	FLOODPLAIN ALLUVIUM	Tw	WASATCH FORMATION
Qta	LOW TERRACE ALLUVIUM	Tfuc	FORT UNION COAL (WYODAK SEAM)
Qaa	FLOODPLAIN AND TERRACE ALLUVIUM OF MINOR STREAMS	Tfu	FORT UNION FORMATION
Qc	SCORIA (BAKED WASATCH FORMATION)	———	APPROXIMATE TOP OF COAL
		– —— –	BASE OF COAL

NOTE: Qfa is within the definition of alluvial valley floors according to the Surface Mining Control and Reclamation Act of 1977 (SMCRA). Qta and Qaa are included, but must be studied in greater detail to determine how much of their area falls within the SMCRA definition. Figure is modified from Williams, 1978.

Figure BU2-4

SIMPLIFIED GEOLOGIC MAP OF BUCKSKIN MINE SITE



LEGEND

Ab Ac	ARVADA SERIES
Ba	BANKARD SERIES
Uc,Ue	BOWBAC SERIES
La	HAVERSON SERIES
Ga,Gb	OLNEY SERIES
Rb,Rc	RENOHILL SERIES
Rh,Rf	SAMSIL - SHINGLE - ROCK OUTCROP

SOURCE: Soil Survey of Campbell, County, Wyoming, July, 1955 with modifications from Shell Oil Company, 1977.

Figure BU2-5
SOILS MAP OF BUCKSKIN MINE SITE

Bankard Series: The Bankard series consists of deep, well-drained, coarse-textured soils forming on alluvial valley floors on low terraces adjacent to streams. Topsoil potential is poor because of sandy textures and gravelly horizons.

Bowbac Series: The Bowbac series consists of moderately deep, well-drained, medium-textured soils forming on gently rolling to moderately steep uplands. Topsoil potential is only fair because of sandy horizons present in the soil profile and shallow depth to bedrock.

Haverson Series: The Haverson series consists of deep, well-drained, medium-textured soils forming on alluvial valley floors on low terraces adjacent to streams. Topsoil potential is good to fair because of gravelly horizons present in the soil profile.

Olney Series: The Olney series consists of deep, well-drained, medium-textured soils forming on gently rolling to moderately steep uplands. Topsoil potential is good to fair because of sandy horizons present in the soil profile.

Renohill Series: The Renohill series consists of moderately deep, well-drained, fine-textured soils forming on gently undulating to rolling uplands. Topsoil potential is poor because of high clay content.

Samsil Series: The Samsil series consists of shallow, well-drained, fine-textured soils forming on ridges and hill slopes. Topsoil potential is poor because of high clay content and shallow depth to bedrock.

Shingle Series: The Shingle series consists of shallow, well-drained, medium-textured soils forming on ridges and hill slopes. Topsoil potential is poor because of shallow depth to bedrock.

Rough Broken Land: This mapping unit is mainly derived from mixed sandstone, siltstone, and shale. Included are escarpments between benches formed by erosion, badly dissected areas, and rock outcrops. Small, shallow stony areas and deep soils are intermingled with the areas of rock outcrop. Topsoil potential is poor because of the variable materials.

Land capability classification refers to a grouping of kinds of soils into special units according to their capability for intensive use and the treatments required for sustained use. This classification system has been prepared by the SCS (1973), which recognizes eight classes of land according to the risk of land damage or the difficulty of land use. Four of these classes are present on the proposed Buckskin Mine site:

Class IV: Soils that have very severe limitations that restrict the choice of plants, require very careful management, or both. Generally the last soil grouping considered suitable for cultivated crops; requires major treatment.

Class VI: Soils that have severe limitations that make them generally unsuited for cultivation and limit their use largely to pasture, or range, woodland, or wildlife food and cover.

Class VII: Soils that have very severe limitations that make them unsuitable to cultivation and that restrict their use largely to grazing, woodland, or wildlife food and cover.

Class VIII: Soils and landforms that preclude their use for commercial plant production and restrict their use to recreation, wildlife, water supply, or aesthetic purposes. Generally, Class VIII soils do not respond to management treatment within agricultural purposes.

Land capability classification has been in use by the SCS for a number of years to assist landowners with their farm and ranch planning. Soil surveys are interpreted into capability groups and range sites (a range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its potential to produce native plants) according to production potential and conservation treatment needs. A complete description of the land capability system is in the regional analysis, Chapter 2, Soils, and the range sites are described in detail in Appendix B of the regional analysis.

Table BU2-1 shows land capability units and range sites for the proposed Buckskin Mine site.

WATER RESOURCES

Groundwater

The groundwater that would be affected if the Buckskin Mine is approved is that in the overburden and coal. It is assumed that part of the water for mine usage would come from aquifers below the coal, and these aquifers would also be affected.

Groundwater occurs in the overburden in the alluvium, which is as much as 20 feet thick, and in sandstone lenses in the Wasatch Formation. Movement of water in the alluvium is in a downstream direction and natural discharge is into the surface water system and by evapotranspiration. Flow of water in the Wasatch, in the area that would be affected by mining, is toward Rawhide Creek. The contours of the water levels in the Wasatch that were furnished by the applicant are essentially the same as the water level contour in the coal. (See Figure BU2-6.) Natural discharge is by springs, evapotranspiration, and into the alluvium.

The applicant, in summarizing the aquifer properties, stated the alluvium could transmit an average of about 8,000 gallons per day through each foot of aquifer width when the hydraulic gradient is 1:1 (gpd/ft.), and the sandstone could transmit about 5,000 gpd/ft. The storage coefficient, which is the volume of water released from, or taken into, storage per unit decline in head per unit surface area of the aquifer, is about 0.05 for the alluvium and in the order of 0.05 for the sandstone.

The contour map of water levels in the coal (Figure BU2-6) indicates the mine site is in an area where water is being discharged from the coal toward Rawhide Creek where it is discharged into the alluvium. The applicant states the coal will transmit an average of about 2,000 gpd/ft. of water and that the storage coefficient is about 0.0006.

The chemical quality of the water from the alluvium, overburden, and coal at the leasehold is similar to that elsewhere in the region. One set of analyses furnished by the applicant is given in the Appendix. The locations of the sampling sites are shown in Figure BU2-7.

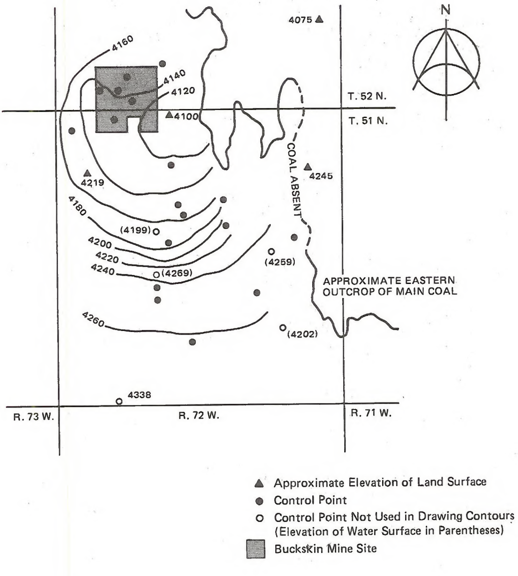
TABLE BU2-1
SOILS, LAND CAPABILITY UNITS, AND RANGE SITES AT PROPOSED BUCKSKIN MINE SITE

Soils	Land Capability	Range Site
Arvada	VIs	Saline lowland
Bankard	IVe	Lowland
Bowbac	VIe	Sandy
Haverson	IVe	Lowland
Olney	VIe	Sandy
Renohill	VIe	Clayey
Rough Broken Land	2/3 VIIe 1/3 VIIIs	1/3 Shallow loamy 1/3 Shallow clayey 1/3 Rock outcrop
Samsil	VIIe	Shallow clayey
Shingle	VIIe	Shallow loamy

Subclasses are groups of capability units which have the same major conservation problem.

s - special soil characteristic such as root-zone limitations or excess salts

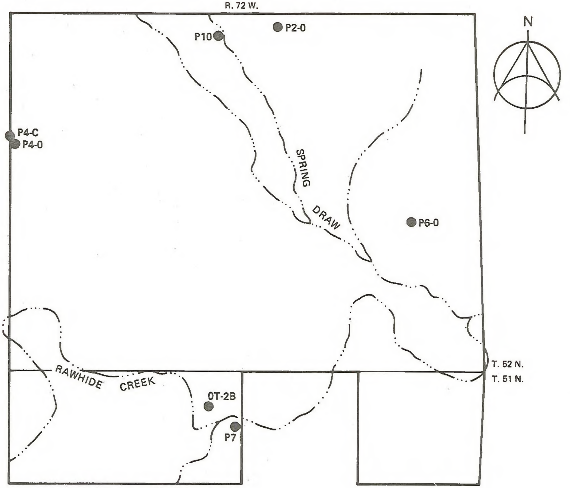
e - erosion and runoff



WATER LEVEL DATA DERIVED FROM SHELL OIL COMPANY, 1977; CARTER OIL COMPANY, 1977; AMAX COAL COMPANY, 1977. EASTERN OUTCROP OF COAL ADAPTED FROM DENSON AND KEEFER, 1974

Figure BU2-6

CONTOUR MAP OF WATER LEVELS IN THE COAL



SOURCE: MODIFIED FROM SHELL OIL COMPANY 1977

●	P2-C	MONITOR WELL AND IDENTIFIER
	C	WELL IN COAL
	0	WELL IN OVERBURDEN

Figure BU2-7
LOCATIONS OF WELLS ON THE BUCKSKIN LEASE FOR WHICH CHEMICAL ANALYSES ARE GIVEN IN APPENDIX

Hydrologic information provided by Shell Oil and given above correlates with other data collected in the region.

Excluding wells drilled by the applicant, there are 6 wells inside or within one-half mile of the lease. There are 46 wells outside ½ mile but within 3 miles of the lease. Twenty of these wells are observation wells at adjoining mines. Other wells were drilled for stock or domestic supplies.

The Surface Mining Control and Reclamation Act of 1977 (SMCRA) defines "alluvial valley floors"for the purposes of the act as "the unconsolidated stream-laid deposits holding streams where water availability is sufficient for subirrigation or flood irrigation agricultural activities but does not include upland areas which are generally overlain by a thin veneer of colluvial deposits composed chiefly of debris from sheet erosion, deposits by unconcentrated runoff or slope wash, together with talus, other mass movement accumulation and windblown deposits" The presence of unconsolidated stream-laid deposits containing groundwater indicates hydrologic conditions within the definition of "alluvial valley floors"are present. Strip mining of the floors would have to comply with the standards established by SMCRA.

Surface Water

Ephemeral streams (flow as a result of precipitation) entering the proposed mine area are both intermittent and interrupted (flow for parts of most years and for short distances at points in the streams). Rawhide Creek enters the area from the west draining about 69.1 square miles, and Spring Draw enters from the northwest draining about 2.13 square miles. (See regional analysis, Chapter 2, for more detailed description of streams and drainage.) Average valley slopes are about 0.3% for Rawhide Creek and 1.2% for Spring Draw. Maximum land surface slopes vary from about 70% to about 100% (1:1).

Surface water flow originating from the approximately 1 square mile of the proposed mining area should amount to about 0.031 cubic feet per second (cfs) or 0.031 cubic feet per second per square mile (cfsm). Streamflow entering the area from the Rawhide Creek drainage should average about 0.80 cfs or 0.012 cfsm, and that from the Spring Draw drainage should average about 0.045 cfs or 0.021 cfsm. Peak streamflows with return periods of 10 years and 25 years (10% chance and 4% chance, respectively, of occurring in any given year) should be about 1,400 cfs and 2,300 cfs respectively for Rawhide Creek and about 400 cfs and 600 cfs respectively for Spring Draw. (Peak flow data was derived from U.S. Department of the Interior 1977, Hodson et al. 1973, and Lowham 1976). Stream slopes are about 0.2% for Rawhide Creek and about 1.1% for Spring Draw; the sinuosities (as measured by the ratio of stream length to valley length) for the two streams are about 1.3 and 1.1 respectively. Flood velocities should vary from about 3 feet per second (fps) to about 5 fps in Rawhide Creek and from about 4 fps to about 7 fps in Spring Draw.

There is only about ½ mile of main channel in the proposed lease area, which could possibly contain point sources of intermittent flow. Reconnaissance on September 30, 1977, indicated water in 0.2 to 0.3 miles of channel. There are about 6 wells and 5 reservoirs, irrigation diversion ditches, and spreader dams in the area (data furnished by the applicant).

Erosion and sedimentation depend upon the energy of the rainfall and water flow, erodibility of the soil, and the protective influence of vegetation. Water-borne sediment originates from sheet erosion and from gulley and channel formation. Shown and others (report in preparation) found that the sediment rate in the vicinity of the mine (based on data from about 20 ranch ponds in Campbell County) varied between about 0.01 to about 0.25 acre-feet per square mile per year. Sediment concentrations from adjoining streams, Little Missouri River near Alzada, Montana and Belle Fourche River below Moorcroft, Wyoming, varied from about 2,000 parts per million (ppm) to about 4,000 ppm in 1949 and 1950 (from annual streamflow data reports of the Geological Survey).

Water quality investigations from several wells and from Rawhide Creek indicate that the water in the lease area is typical of water found in the Gillette area, i.e., highly mineralized, and it exceeds the recommended maximum concentration for domestic or municipal use for one or more constituents. Several well samples showed some trace elements above the U.S. Public Health Service's suggested limits for drinking water. Surface water samples showed that streamflow had a dissolved oxygen content lower than expected; that it was high in dissolved solids; and that it could be characterized as magnesium/sodium/ sulfate type water. (Water quality information was derived from Shell Oil's mining and reclamation plan, which is on file at the Bureau of Land Management's Casper District Office. See water quality tables in appendices of regional and site-specific analyses).

Water is presently used on the proposed mine site for stock and wildlife watering and for sub and flood irrigation of hay.

VEGETATION

The Buckskin Mine site is considered to be in a vegetative transition zone between the northern desert shrub type and the shortgrass plains type. The transition zone is frequently dominated in appearance by sagebrush, but contains numerous grass and forb species common to the shortgrass communities of the Great Plains. The proposed Buckskin Mine site, in particular, is more representative of true shortgrass plains than the surrounding areas. This condition is likely a result of past management practices which prevented serious overgrazing of the property.

Terrestrial Vegetation

As shown in Chapter 1, the Buckskin permit area consists of a main mining area, a railroad route, and access roads. The acreages of all these areas are included in the following discussion. The vegetation map, however, is confined to the main mining area (lease plus 1,000-foot perimeter).

The following information was derived from the applicant's mining and reclamation plan. Five primary vegetation types exist on the Buckskin mine permit area: playa grassland, sandhills grassland, big sagebrush, silver sagebrush, and riparian. In addition to these types, there is some scattered cultivated land on the mining area.

The vegetative types within the proposed mining area have been delineated in Figure BU2-8; they are described in the following paragraphs, and are keyed to the map.

Playa Grassland Type (map symbol 1A) 5 acres

This vegetation type covers the smallest portion of the total permit area. Vegetation of the playa type is dominated by grasses and grasslike species. Important species found here are western wheatgrass *(Agropyron smithii)*, Kentucky bluegrass *(Poa pratensis)*, rush *(Juncus* spp.) and sedges *(Carex* spp.). Common dandelion *(Taraxacum officinale)* and Louisiana sagewort *(Artemisia ludoviciana)* are also found in this vegetation type.

Sandhills Grassland Type (map symbol 1C) 298 acres

Grasses and forbs predominate in this vegetation type, comprising approximately 81% of the vegetative cover. Prairie sandreed *(Calamovilfa longifolia)*, needle-and-thread *(Stipa comata)*, blue grama *(Bouteloua gracilis)*, and prairie junegrass *(Koeleria cristata)* are the common grasses. Forbs and shrubs include silverleaf scurfpea *(Psoralea agrophylla)*, hairy goldenaster *(Heterotheca villosa)*, fringed sage *(Artemisia frigida)*, and silver sagebrush *(Artemisia cana)*.

Big Sagebrush Type (map symbol 4) 662 acres

This vegetation type is the most extensive on the Buckskin permit area and is characterized by the presence of big sagebrush *(Artemisia tridentata)* as the predominant shrub. Grass and grasslike species of primary importance include western wheatgrass, blue grama, needle-and-thread, prairie junegrass, and threadleaf sedge *(Carex filifolia)*. Other common species are Hood's phlox *(Phlox hoodii)*, milkvetch *(Astragalus* spp.), broom snakeweed *(Gutierrezia sarothrae)*, fringed sage, and silver sagebrush.

Silver Sagebrush Type (map symbol 4A) 478 acres

A predominance of grasses interspersed with clumps of silver sagebrush characterizes this vegetation type on the permit area. The most important grass and grasslike species are needle-and-thread, blue grama, western wheatgrass, and threadleaf sedge. Important forbs and shrubs are scarlet globemallow *(Sphaeralcea coccinea)*, and fringed sage. Plains pricklypear cactus *(Opuntia polycantha)* is found infrequently in sandy depressions.

Riparian-Bottomland Type (map symbol 10) 148 acres

Total vegetative cover is highest in this vegetation type (62.6%), with grasses making up 57% of the total. Important grasses are Kentucky bluegrass, prairie cordgrass *(Spartina pectinata)*, and inland saltgrass *(Distichlis spicata)*. Other common species include sedges, baltic rush *(Juncus balticus)*, and yellow sweetclover *(Melilotus officinalis)*. The vegetation of Rawhide Creek is indicative of an alluvial valley floor, and is mapped as such by Williams (1978) (Figure BU2-4).

Cultivated Lands (map symbol 19) 169 acres

The scattered cultivated lands comprise approximately 10% of the total lease and perimeter area. These lands include several areas that have been seeded only to native or introduced grasses as a range improvement or for hay production. The primary species occurring in this area is intermediate wheatgrass *(Agropyron intermedium)*. This area is generally harvested for hay each summer. Some barley and wheat are also grown. (See Chapter 2, Agriculture.)

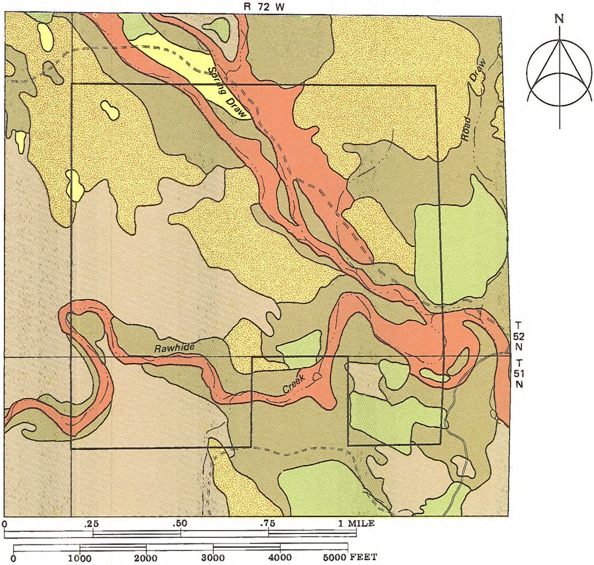
Aquatic Vegetation

Rawhide Creek flows during periods of snowmelt in the spring and after summer thunderstorms. During the remainder of the year, surface water in Rawhide Creek consists of isolated pools of perhaps 100 square feet or less with depths of 2 to 6 inches. Aquatic vegetation is limited to species which require wet ground, but which can exist for long periods without standing water, if other moisture is available from subirrigated alluvium, subsurface springs, or overflowing water tanks. Main species observed in Rawhide Creek include bulrush *(Scirpus* spp.), common cattail *(Typha latifolia)*, sedges, watercrowfoot *(Ranunculus aquatilis)*, and filamentous green algae. The predominant species observed was watercrowfoot which completely filled the pools.

Temporary surface water exists in the playas near the west lease boundary. Each playa drains less than 40 acres. Semiaquatic vegetation in the playas consists primarily of sedges. Aquatic flora is probably limited to a few species of algae.

Endangered and/or Threatened Species

No plants which have been identified as threatened or endangered, or are proposed for such designation, have been found on the proposed mining area (Shell Oil Company 1977). A plant specialist from the Wyoming De-



LEGEND

PLAYA GRASSLAND

SANDHILLS GRASSLAND

BIG SAGEBRUSH

SILVER SAGEBRUSH

RIPARIAN - BOTTOMLAND

CULTIVATED

MODIFIED FROM SHELL OIL COMPANY, 1977

Figure BU2-8
GENERAL VEGETATION MAP OF BUCKSKIN MINE SITE

partment of Environmental Quality has conducted a survey, at the request of the Bureau of Land Management, and has verified the applicant's conclusion (personal communication 1978).

FISH AND WILDLIFE

Habitat Types

The six habitat types found on the proposed mine site and the wildlife species normally associated with each type are listed below. Acreages shown in parentheses are those that would actually be disturbed by mining.

Sagebrush-Grass (Big Sagebrush) (447 acres). Horned lark, lark bunting, vesper sparrow, Brewer's sparrow, deer mouse, northern grasshopper mouse, least chipmunk, white-tailed jackrabbit, coyote, mule deer, pronghorn antelope.

Silver Sagebrush (278 acres). Brewer's sparrow, lark bunting, western meadowlark, vesper sparrow, deer mouse, desert cottontail, pronghorn antelope, mule deer.

Riparian (72 acres). Cliff swallow, red-winged blackbird, barn swallow, mourning dove, mallard, blue-winged teal, pintail, killdeer, Wilson's phalarope, meadow vole, deer mouse, muskrat, mule deer, snapping turtle, leopard frog, chorus frog.

Sandhills Grassland (149 acres). Vesper sparrow, horned lark, mourning dove, western harvest mouse, northern pocket gopher, desert cottontail, red fox, pronghorn antelope.

Playa Grassland (4 acres). Savannah sparrow, western meadowlark.

Cultivated Land (121 acres). Savannah sparrow, western meadowlark, mourning dove, western harvest mouse, northern pocket gopher, desert cottontail, white-tailed jackrabbit.

Fishery

Approximately 1½ miles of Rawhide Creek lie within the area that would be disturbed by the proposed Buckskin Mine. Rawhide Creek is an intermittent stream which contains standing pools of water yearlong. Field investigations by the Wyoming Game and Fish Department (1978) revealed the presence of fathead minnows in some of the pools in Rawhide Creek. A single green sunfish was also observed.

Wildlife

The wildlife observation data and density figures which follow were provided by Shell Oil Company (1977) and the Wyoming Game and Fish Department (1978), unless otherwise noted. These data are consistent with other information gathered in the region (see Chapter 2 of the regional analysis). See Table BU2-2.

Birds

Nongame. The primary nongame bird species observed on the proposed Buckskin site were vesper sparrow, Brewer's sparrow, grasshopper sparrow, lark bunting, western meadowlark, brown-headed cowbird, red-winged blackbird, and Brewer's blackbird. Shorebirds observed on the site included spotted sandpipers, killdeer, and Wilson's phalaropes. Density figures derived from field investigations conducted by the Wyoming Game and Fish Department (1978) are shown in Table BU2-2.

Raptors. Raptor species observed on the site were Swainson's hawk, American kestrel, marsh hawk, red-tailed hawk, ferruginous hawk, prairie falcon, golden eagle, and great horned owl. An active red-tailed hawk nest was found in 1978 by Wyoming Game and Fish Department investigators in an area that would be mined. Several other active nests were found within 2 miles of the proposed mine site. Raptor density on the site is estimated to be 4.8 per square mile.

Game. Mourning doves are the most common game bird on the site. Densities by habitat type for this species are shown in Table BU2-2. Sage grouse and sharp-tailed grouse have been observed on the site, but no density data were gathered. Investigators working for the applicant did not observe either of these birds in 1975 or 1976.

Waterfowl observed on the site included blue-winged teal, green-winged teal, pintail, shoveler, American widgeon, and mallard. Density estimates for waterfowl are 6.6 per square mile (Shell Oil 1977).

Sensitive Species. The burrowing owl is the only state-listed sensitive species known to occur in the general vicinity of the proposed mine area. None was observed on the area that would be disturbed.

Endangered and/or Threatened Species. Bald eagles are known to winter in the Eastern Powder River Basin, and peregrine falcon and whooping crane may migrate through the region (personal communication, Harry Harju, Wyoming Game and Fish Department 1978). No observations of endangered and/or threatened bird species on the proposed mine site have been reported. Based on their previous studies, the Wyoming Game and Fish Department is satisfied that no endangered and/or threatened birds exist on the mine site (ibid.).

Mammals

Nongame. The most common small mammal species observed on the proposed site were deer mouse, thirteen-lined ground squirrel, and northern grasshopper mouse. Density estimates for small nongame mammals are presented in Table BU2-2 by habitat type.

White-tailed jackrabbit density on the site is estimated to be 5 per square mile.

Furbearers/Predators. Predator species occurring on the site are coyote, raccoon, and red fox. Muskrat and badger have also been observed on the site. No density information is available for muskrats, coyotes, or rac-

TABLE BU2-2

TERRESTRIAL WILDLIFE DENSITIES ON THE BUCKSKIN MINE SITE
(Number per Acre)

	All Habitat	Sandhills Grasslands	Playa Grassland	Big Sagebrush	Silver Sagebrush	Riparian
Birds						
Nongame*		1.31		1.23	1.55	3.57
Raptors**	4.8/sq. mi.					
Game						
Mourning Dove*		.004		.01	.02	.08
Sage Grouse		No density data, but observed on the site.				
Sharp-tailed Grouse		No density data, but observed on the site.				
Gray Partridge		No density data, but observed on the site.				
Waterfowl**						6.6/sq. mi.
Mammals						
Nongame						
Small Mammals*		4.4		2.75	8.8	14.9
White-tailed Jackrabbits**	5.0/sq. mi.					
Furbearers/Predators						
Muskrat		No density data, but observed on the site.				
Badger**	1/sq. mi.					
Coyote		No density data, but observed on the site.				
Red Fox**	.4/sq. mi.					
Raccoon		No density data, but observed on the site.				
Small Game**						
Desert Cottontail	3.3/sq. mi.					
Big Game						
Pronghorn***	9.47/sq. mi.					
Mule Deer**	.5/sq. mi.					

* Wyoming Game and Fish Department 1978

** Shell Oil Company 1977

*** Average of summer density data collected by Shell Oil Company in 1975 and 1976, and data collected by the Wyoming Game and Fish Department in 1978.

coons on the site. Badger density is estimated at one per square mile.

Game. Cottontail rabbit density is estimated to be 3.3 per square mile.

The Buckskin Mine site is in an area classified by the Bureau of Land Management as winter-concentration-yearlong antelope range. Antelope density on the site is estimated at 9.3 per square mile during the summer. During the winters of 1977-78 and 1978-79, pronghorn gathered in large numbers just south of the mine site. Approximately 300 animals crossed the proposed mine and access road to reach their preferred wintering area.

Mule deer density on the proposed mine site is estimated at 1 per 2 square miles. Mule deer numbers should not be subject to seasonal fluctuation because the area is used as yearlong range.

Endangered and/or Threatened Species. The only endangered and/or threatened mammal which may occur in the region is the black-footed ferret. Prairie dog towns are considered primary ferret habitat. No prairie dog towns exist on the Buckskin site, and the Wyoming Game and Fish Department is satisfied that ferrets are not present (personal communication, Harry Harju 1978).

Amphibians and Reptiles

The two amphibians observed on the proposed mine site were the leopard frog and chorus frog. The applicant states one leopard frog was observed per 10 feet of stream channel, and one chorus frog was observed per 20 feet of stream.

A plains garter snake and a snapping turtle was the only reptiles observed on the site.

Endangered and/or Threatened Species. No known endangered or threatened amphibian or reptile species are known to occur in the region or, therefore, on the project area.

CULTURAL RESOURCES

No sites in the Buckskin permit area are currently listed on the Wyoming Historic Preservation Plan or on the National Register of Historic Places. Two sites are determined eligible for listing, however.

Prehistoric

The entire Buckskin permit area was surveyed by the University of Wyoming (Zeimens and Walker 1977 and Zeimens et al. 1978). Two sites (48 CA 16 and 48 CA 17) are within the area which would be mined; they contained stone flakes, projectile points, and fragments of bone and shell. Neither site is considered to be of National Register quality by the archeological survey crew (Zeimens et al. 1978).

Two prehistoric sites lie outside the area to be mined. One (48 CA 89) is an extensive group of stone circles with associated Late Prehistoric Period (1700 to 300 years before the present) artifacts. The portion of the site lying within the proposed rail access line to the mine was tested and recorded. The other site (48 CA 130) is an arroyo trap bison kill which also lies partially within the proposed rail right-of-way. It too was extensively tested in areas where it was likely to be affected. Eligibility for protection under the historic preservation laws is established for 48 CA 89 and 48 CA 130 (Zeimens et al. 1978). Appropriate consultation among the State Historic Preservation Officer, the Bureau of Land Management, and the Advisory Council for Historic Preservation will take place regarding all sites present on the lease.

There is a possibility that buried archeological deposits exist along Rawhide Creek. Should such sites of potential National Register significance be indicated during overburden removal, appropriate mitigation would be conducted in consultation with the State Historic Preservation Officer and the Advisory Council as required in Section 106 of the Historic Preservation Act.

Historical

Recorded history began for the Buckskin Mine site in 1883 when section corners were set. The first application for a homestead was filed in 1902 and a second in 1903. The remaining acreage transferred to private ownership after 1916 and before 1925. The intensive cultural resource inventories conducted in the permit area did not reveal any physical evidence of these activities.

VISUAL RESOURCES

The characteristic landscape of the proposed Buckskin Mine site is open country with low rolling hills, scattered buttes, and occasional creek bottoms. There is little water or variation in vegetation, and there are no unique visual factors. Man-made intrusions into this setting are ranch buildings and equipment, roads, utility lines, and nearby coal mines. The western edge of the permit area and some of the high spots can be seen by people traveling south on U.S. Highway 14/16 for approximately 1½ miles at a distance of 1 mile.

A visual resource inventory was conducted using the Bureau of Land Management's visual resource inventory and evaluation procedures (see regional analysis, Appendix B). The area falls into scenery quality Class C, because it lacks variety in landform, color variation, and color contrast. The permit area is in the foreground-middleground view zone, and has been identified as having medium visual sensitivity. Based upon the visual evaluation, the entire permit area has been assigned a Class IV visual resource management designation. This means that if the land involved were public, the Bureau of Land Management would allow permanent changes which alter the original visual character, but which reflect only what could be natural occurrences.

RECREATION RESOURCES

Recreation participation is limited on the proposed Buckskin Mine site because the land surface is privately owned. Hunting for antelope, mule deer, small game, and upland game birds is probably the only recreation opportunity. At the present time, the owner (Shell Oil) leases its property for grazing, and permission to hunt on the land is at the discretion of the lessee.

AGRICULTURE

Livestock Grazing

The land within the Buckskin Mine permit area is currently used for livestock grazing on an intermittent basis.

At the present time cattle ranching operations are being conducted by two operators. Cattle graze the main mining area (lease and 1,000-foot perimeter) during spring and summer for a yearly use of 243 animal unit months (AUMs). All permit areas (main mining area, railroad, and access road) have an annual capacity of 320 AUMs.

Livestock water is provided by Rawhide Creek as well as a few ponds located on Spring Draw. Both quality and quantity of water appear adequate for present livestock use. Most of the riparian zone along Rawhide Creek in the southeast corner of Section 32 is grazed each year and also harvested for hay each summer.

Farming

Small scattered portions of the main mining area are being utilized on an intermittent basis for the production of hay and grain. Approximately 32 acres are utilized for the production of barley; they provide a yield of 25 to 40 bushels per acre. Two acres of wheat yield 25 to 30 bushels per acre. Hay production amounts to 1,000 to 2,000 pounds per acre on 87 acres, depending on climatic conditions. See Figure BU2-8 for the location of these scattered tracts.

Meadows and the acreages planted to introduced grasses are used for livestock grazing every year and are harvested for hay in years when precipitation is sufficient. No irrigation techniques are used on the area. Moisture is received from precipitation, flooding, and natural subirrigation.

Agricultural land must meet certain criteria (established by the Surface Mining Control and Reclamation Act (SMCRA)) to be classified as prime farmland. Because the Buckskin Mine site has no developed irrigation or dependable water supply system, and because annual precipitation is 14 inches or less, these criteria are not met. Therefore, prime farmland, as defined by SMCRA, does not exist on the site. The Soil Conservation Service, as well, has not made a determination that prime farmland exists on the site.

Approximately 18 acres of cultivated land are located within and adjacent to the alluvial valley of Rawhide Creek. Intermittent farming practices, particularly hay cutting, are carried out on this cultivated land.

MINERAL RESOURCES

The coal bed to be mined at Buckskin is the Anderson-Canyon (Wyodak) at the top of the Fort Union Formation. It ranges in thickness from 0 to 125 feet, and averages about 107 feet. This thickness includes 2 to 5 feet of shale parting just above the middle of the seam.

The coal reserve at Buckskin is estimated by the applicant to be 84 million tons, of which 80 million tons is recoverable by present mining methods. (Four million tons of coal would be either left in the lease boundary highwalls or mixed with overburden and partings.) The coal is subbituminous in rank and has a heat rating of 8,183 BTUs per pound. On an undiluted, as received basis, it contains .51% sulphur, 29.8% moisture, and 6.11% ash.

There is no other ongoing or potential mineral development on the Buckskin site.

TRANSPORTATION NETWORKS

Railroads

The Burlington Northern (BN) is the rail system which serves Campbell County. The railroad line that passes through Gillette begins in Huntley, Montana, at a connection to the BN east-west Spokane, Washington to Fargo, North Dakota main line (see Figure BU2-9). From this point, the route follows a generally southeasterly alignment passing through Sheridan and Gillette, the southwest corner of South Dakota, and most of Nebraska before reaching Lincoln, Nebraska. The main railroad system is discussed in detail in the regional analysis, Chapter 2.

Near Donkey Creek, a branch line leaves the main line in a northerly direction (see Figure BU2-9). This line has been established as far as the Carter Oil Company's Rawhide Mine. The Buckskin Mine would be served by a 6-mile spur line to be extended northwest from the end of the line serving the Rawhide Mine.

Highways

The major highway serving the immediate area of Buckskin Mine site is U.S. Highway 14/16, which runs north and south to the west of the lease. State Highway 59 runs north out of Gillette and passes east of the lease (Figure BU2-10). Several unimproved dirt roads which provide access for local traffic presently exist on or near the lease area.

Traffic flow in 1958 on four sections of U.S. Highway 14/16 near the mine site is compared to traffic flow in

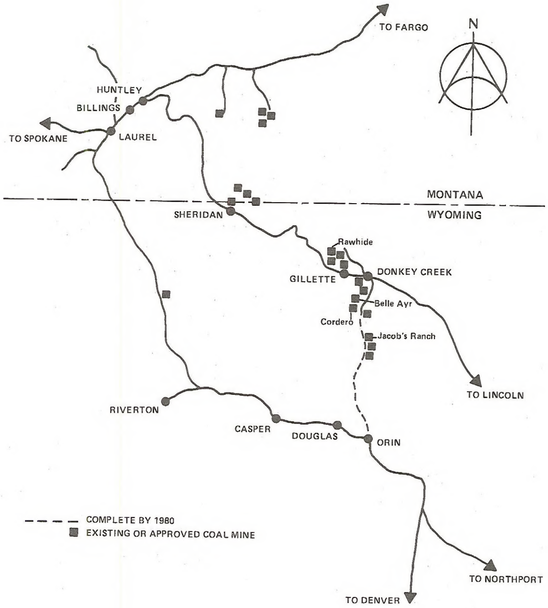


Figure BU2-9
BURLINGTON NORTHERN RAILROAD SYSTEM
POWDER RIVER BASIN

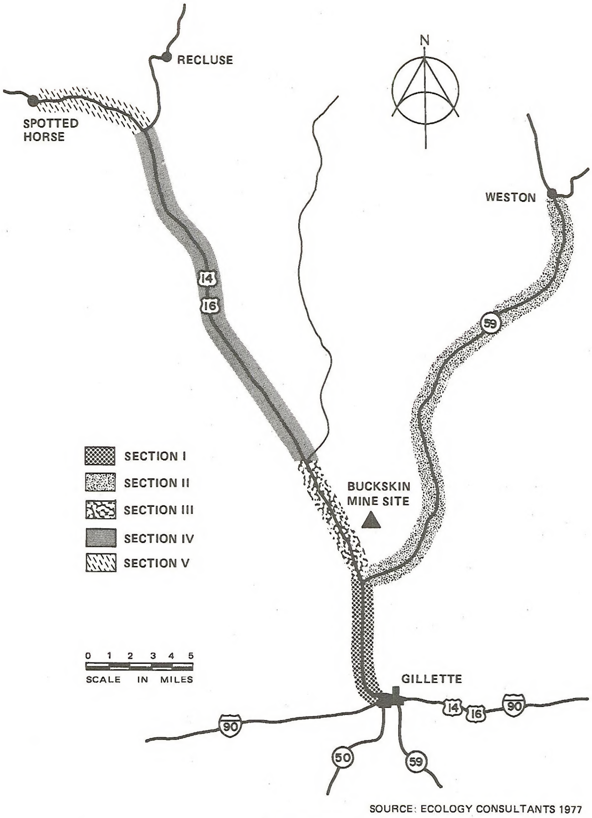


Figure BU2-10

MAJOR HIGHWAYS IN THE VICINITY OF THE PROPOSED BUCKSKIN MINE

years 1970 through 1975 on Figure BU2-11. Traffic flow for these years on two portions of State Highway 59 is given on Figure BU2-12. In 1958, before Interstate 90 was completed, virtually all traffic past the proposed Buckskin Mine site was through traffic. More recent traffic figures (1970 through 1975) illustrate that vehicular traffic has shifted to local traffic. As shown on Figure BU2-11 and Figure BU2-12, traffic levels have remained nearly the same or increased near Gillette and the lease area, whereas traffic levels have decreased on sections of U.S. Highway 14/16 and State Highway 59 farther north of Gillette. The increase near Gillette is likely due to the expansion of the coal and oil industries which has occurred in recent years.

In Gillette itself, 97% of the residents feel there is a definite need for improved city streets (City of Gillette/ Campbell County Department of Planning and Development 1977 Citizens' Policy Survey).

Other

The Gillette-Campbell County Airport provides chartered and air taxi service. Almost 80% of Campbell County residents responding to the 1977 Citizens' Policy Survey agreed that the airport needs improved facilities. Total air operations at the Gillette-Campbell County Airport for 1976 were 53,578 (personal communication, Sam Stafford 1977).

Bus service is provided to Gillette from Casper, Wyoming and Billings, Montana by Continental Trailways. Telephone service is supplied for the Gillette area by Mountain Bell.

SOCIOECONOMIC CONDITIONS

Introduction

A description of existing socioeconomic conditions in the eight northeastern counties of Wyoming can be found in the regional analysis, Chapter 2. This site-specific analysis concentrates on socioeconomic conditions in Campbell County and Gillette, where the effects of population increase due to the proposed Buckskin Mine would be felt.

Sociocultural Profile

It is possible to distinguish some of the differences and similarities between newcomers and old-timers in Gillette by analyzing data collected by the Wyoming Services Project of the University of Wyoming in 1976 *(Campbell County Parks and Recreation Department Citizens' Survey)*. The study indicates that newcomers tend to be younger, better educated, less rural (based only on their latest place of employment), and that they have a lower unemployment rate than their old-timer counterparts in Gillette. Newcomers depend more on mobile homes for their dwellings than do old-timers. The two groups have similarities in terms of their basic geographic backgrounds, and in their racial and religious homogeneity. Both groups have similar family sizes, work about the same number of hours per week, have high average incomes relative to the rest of the state, and depend heavily on mineral development-related work for their incomes.

The boom-town conditions in Gillette are such that one area psychologist, Dr. E. L. Dean Kohrs, has coined the phrase "the Gillette syndrome"to characterize its conditions (1975). He has described the Gillette syndrome as a "social system of higher rewards and greater pains"that accompanies a boom-town growth situation. He feels it "... includes the three A's— alcohol, accidents, and absenteeism, as well as the three D's--divorce, delinquency, and depression"

Economic Profile

Local Demography

Table BU2-3 shows population figures from 1950 to the present.

Campbell County experienced a 121% population increase between 1960 and 1970, owing primarily to an oil boom. Many new residents during this period settled in Gillette, causing the city to grow at an average annual rate of 5.6% per year.

During the past 8 years, the development of coal resources in the county has been primarily responsible for an 50% increase in the population, from 12,957 in 1970, to an estimated 26,080 in 1978. Gillette's population increased 62% from 7,763 to an estimated 20,450 during the same period, making it the fifth largest city in the state in 1978.

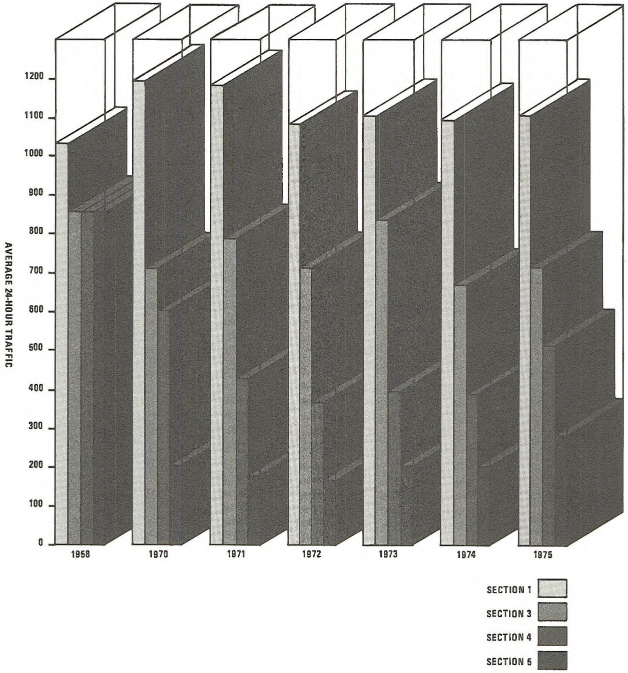
Employment and Income

Recent data show a marked increase since 1970 in employment levels and income values. The change is due to inflation and the rapid population increase, most of which consists of skilled construction and mine workers. Between 1970 and 1975, the number of wage and salary employees in Campbell County rose by 1,710—an average annual increase of 6.4%.

Table BU2-4 shows the distribution of total employment by sector in Campbell County in 1970 and 1975. The table demonstrates the change, or evolution, in employment.

During the last 5 years, unemployment in Wyoming has varied between 3% and 5%. Unemployment in Campbell County during September, 1977, was 2.2%, lower than the state and national averages of 2.8% and 6.9% (seasonally adjusted) respectively.

It is interesting to note that although relative sectoral employment remained fairly stable over the period between 1970 and 1975, the distribution of personal income



SOURCE: ECOLOGY CONSULTANTS 1977

Figure BU2-11

TRAFFIC FLOW ON U.S. HIGHWAYS 14/16 IN VICINITY OF BUCKSKIN MINE SITE

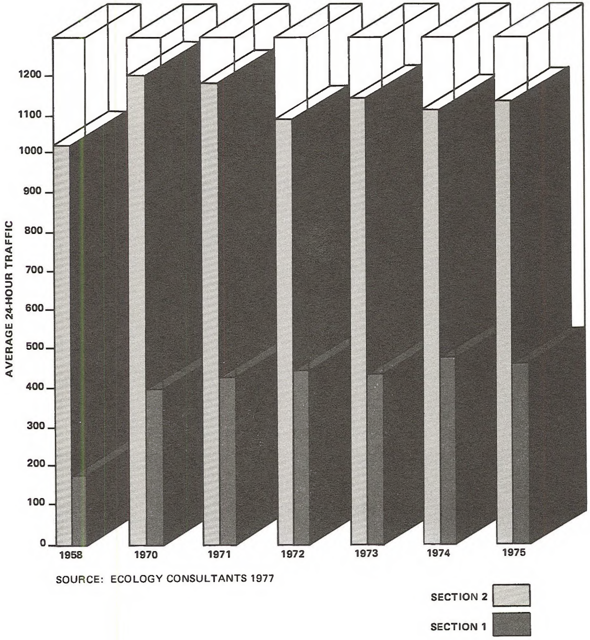


Figure BU2-12

TRAFFIC FLOW ON STATE HIGHWAY 59 IN VICINITY OF BUCKSKIN MINE SITE

TABLE BU2-3

POPULATION OF CAMPBELL COUNTY AND THE CITY OF GILLETTE (1950-1976), AND PROJECTED POPULATION OF CAMPBELL COUNTY (1977-1990)

	CAMPBELL COUNTY		CITY OF GILLETTE		CAMPBELL COUNTY EXCLUSIVE OF CITY OF GILLETTE	
Year	Population	Annual rate of change in percent*	Population	Annual rate of change in percent*	Population	Annual rate of change in percent*
1950	4,839	---	2,191	---	2,648	---
1960	5,861	+2	3,580	+5	2,281	-1
1970	12,957	+8	7,763	+8	5,194	+9
1973	12,283	-2	7,801	**	4,482	-5
1975	13,090	+3	8,215	+3	4,875	+4
1978	26,080	+4	20,450	---	5,630	---

Source: U.S. Department of Commerce, Bureau of the Census, November 1970, April 1977, July 1977.

* Average rate of change compounded annually.
** Less than 1%.

TABLE BU2-4

WAGE AND SALARY EMPLOYMENT FOR CAMPBELL COUNTY
1970-1975

	1970	Percent of Total	1975	Percent of Total
Agriculture	157	(3.3)	188	(2.9)
Minerals	1,109	(23.6)	1,402	(21.9)
Construction	473	(10.1)	1,031	(16.1)
Manufacturing	27	(0.6)	84	(1.3)
Business and Consumer Services	2,157	(46.0)	2,733	(42.7)
Government and Education	767	(16.3)	962	(15.0)
Military	5	(0.1)	4	(0.1)
Total Wage and Salary Employment	4,694		6,404	

Source: U.S. Department of Commerce, Bureau of Economic Analysis (BEA) 1977.

Note: Table includes full- and part-time workers. BEA data on which this table is based deleted sector employment data where necessary to preserve confidentiality. In preparing this table, estimates were made of deleted items.

changed dramatically. For example, farm income accounted for 13.9% of personal income in 1970 but only accounted for 0.6% of the personal income in 1975 (see Table BU2-5). Over the same time frame, manufacturing, mining, and construction were all experiencing an increase, both relatively and absolutely, in personal income. In fact, personal income from mining increased by $15.1 million or 139%, construction increased by nearly $10 million or 199%, and manufacturing revealed a 622% increase which amounted to slightly less than $1.1 million. The total increase in personal income amounted to a little over $36 million, which translates into a 92% increase over the 5-year period between 1970 and 1975.

Cost of Living

The boom-town atmosphere created in Campbell County by the impact of current and anticipated coal mining has directly affected local residents. Gillette ranked as the most expensive place in Wyoming to live in the third quarter of 1977 for the seventh consecutive quarter, according to the Wyoming Department of Labor and Statistics (November 9, 1977). The Wyoming cost of living index for Gillette was 107.61 (100 is the average cost in Wyoming). Housing is the expense that affects local residents the most. The cost index for the third quarter was 123.43, by far the highest above average in the six categories used to compute the cost of living index. The second highest expense was medical care with a cost index of 110.72.

The Public Sector

Introduction

Boom-town conditions such as exist in Gillette affect local services and finances. Annual population growth rates in excess of 10% strain the capacity of local facilities and services supplied by both the public and private sectors of the local economy. Although both sectors often face critical constraints on capital, labor, and time, impacts are apt to be acute in the public sector, because local government is subject to more stringent procedural and financial constraints and is highly visible to local residents.

Existing development of energy resources in Campbell County has not only strained local facilities and services, such as streets, water supply, sewers, and police and fire protection; development has also laid stress on local government itself and its planning function.

Land Use Patterns

The urban sprawl developing around Gillette is a symptom of rapid and often poorly controlled growth. The total acreage of the city in 1977 tripled from the 1965 amount (Table BU2-6). Residential acreage alone increased 33% during 1977. Land demand forecasts made for the Gillette urban area through 1990 estimate that 1,120 to 1,820 acres of private land will be developed (Table BU2-7). During the period 1972 through 1976, total building permit valuations issued by the City of Gillette/Campbell County Building Department jumped tenfold.

The Gillette urban area contains many areas of mixed land use. This pattern is most obvious in the original part of Gillette where the central business district is expanding into areas that have been primarily residential. The development along State Highway 59 has randomly mixed areas of residential, commercial, recreational, and industrial land use. This pattern of development also tends to occur outside the city limits.

Patchwork or "leapfrog"development results in enclaves of undeveloped land left within the urban area as development spreads outward from the city. Land speculation and the higher costs of development in the city have accelerated this tendency. Numerous mobile home subdivisions have recently developed in Campbell County outside of the Gillette urban area. Leapfrog development and the mobile home subdivisions complicate services such as mass transit, and police and fire protection.

The 1977 Citizens' Policy Survey (City of Gillette/Campbell County Department of Planning and Development) reflects local concerns about zoning and building codes and their enforcement. Of those surveyed, 75% either "agreed"or "strongly agreed"with the statement, "Zoning ordinances should be strictly and consistently enforced" Similarly, 79% felt that, "Zoning can protect property values and properly guide community development if enforced" Concerning building codes, 71% "agreed"or "strongly agreed"with the statement; "Uniform building codes should be adopted and enforced in platted subdivisions in unincorporated areas of Campbell County" Thus, local citizens appear to be aware of the implications of the land use patterns and construction practices that are occurring, and they feel that zoning and building codes should be used to shape future growth. While Gillette has both zoning and building codes, Campbell County has no zoning requirements and has only a plumbing code. The adequacy of zoning and building code enforcement is unknown.

Planning

The Gillette Planning Commission was formed in 1963, and a city master plan was adopted in that year. In 1968, a joint City of Gillette/Campbell County Planning Department was formed. The city's master plan was updated in 1973. The planning department has developed a land use plan for the Gillette urban area—the 6 mile by 5 mile area defined by the Gillette zoning ordinance. Planning for the impact of new coal mining has had high priority in the city administration since January 1975.

The final draft of the comprehensive plan for Campbell County, as required in part by the 1975 Wyoming Land Use Planning Act, was completed by the City of Gillette/Campbell County Department of Planning and Development in June 1978. It was subsequently ap-

TABLE BU2-5

EARNINGS BY SECTOR FOR CAMPBELL COUNTY 1970-1975
(THOUSANDS OF CURRENT DOLLARS AND AS A PERCENT OF TOTAL EARNINGS)

	1970	Percent	1975	Percent
Farm	5,482	(13.9)	462	(0.6)
Manufacturing	172	(0.4)	1,242	(1.6)
Mining	10,909	(27.6)	26,057	(34.4)
Construction	4,985	(12.6)	14,883	(19.6)
Business and Consumer Services	15,594	(39.4)	29,404	(38.8)
Government and Education	2,160	(5.5)	3,430	(4.5)
Military	254	(0.6)	375	(0.5)
Total Income	39,556		75,853	

Source: U.S. Department of Commerce, Bureau of Economic Analysis 1977.

Note: Where the source contained deleted items, figures were estimated.

TABLE BU2-6

LAND USE - CITY OF GILLETTE

Land use Types	1965 Total Acres	1965 % of Developed Acres	1976 Total Acres	1976 % of Developed Acres	1977 Total Acres	1977 % of Developed Acres
Residential	176.8	33.6%	480	32%	642	33%
Commercial	41.9	8%	115	7%	13.1	7%
Industrial	75.6	14.4%	160	11%	160	10%
Utility			50	3%	50	3%
Public-Semipublic	86.7	17%	120	7%	120	7%
Recreational	5.4	1%	150	10%	150	9%
Sreets & Alleys	136.3	26%*	405	27%*	450.85	29%*
Developed Areas	525.7	100%	1,480	100%	1,705	100%
Undeveloped Areas	523.9		1,090		1,342	
Interstate Right-of-way	______		280		280	
Total Acres	1,049.6		2,850		3,327	

Source: City of Gillette/Campbell County Department of Planning and Development 1978.

* This figure includes major streets. Within single-family developments, 20% is a desirable figure.

TABLE BU2-7

LAND DEMAND FORECASTS FOR THE GILLETTE URBAN AREA 1976-1990

General Land Use Category	Low Range Forecast	High Range Forcast
Residential	1,120 acres	1,820 acres
Retail	29 acres	80 acres
Commercial Office, Institutional & Related	9 acres	17 acres
Industrial	48 acres	90 acres
Total	1,206 acres	2,007 acres

Source: City of Gillette/Campbell County Department of Planning and Development 1978.

proved by the city, the county, and the State of Wyoming. The comprehensive plan is: (1) the official statement of policy regarding the future development of the county, (2) a summary of a broad range of available information, and (3) a long-range planning program. See Chapter 3 of the regional analysis for further information.

There is as yet no publicly stated federal policy for future development of federally owned coal in Campbell County. Of those surveyed in the 1977 Citizens' Policy Survey, 57% felt that local citizens had no real opportunity to participate in the decisions made at the federal level regarding energy development, while 22% felt they did.

Local Government

In 1968, Gillette's annual budget was $812,000. The 1977-1978 budget is $7,348,000, more than nine times the size of the 1968 budget. The current city budget is 28% greater than the previous year's budget. A city administrator was hired during 1977 to help the mayor govern the city. The city government, in conjunction with the town of Moorcroft, Wyoming, recently obtained a $50,000 management program grant, funded by the Federal Energy Administration and the state government, to improve the city's administrative ability. Increased demand for county services caused the Campbell County government to increase its 1977-78 budget to $4,430,000, up 44% from the previous fiscal year.

Fire Protection

Fire protection is provided by the City of Gillette/Campbell County Fire Department under direction of a fire board and a county fire warden. The department consists of a full-time fire chief and 4 firemen, supplemented by approximately 19 active volunteer firemen. The city and county each fund the department through a one-half mill levy on personal property. The 1977-78 budget is $178,000. Of those responding to the 1977 Citizens' Policy Survey, 39% felt fire protection was adequate, while 32% felt that it needed improvement.

Police Protection

Police protection is provided in Gillette by a 26-person force. The sheriff's department provides protection for the entire county, including the city. The 1977-78 budget for the Gillette Police Department is $614,000; that of the sheriff's department is $404,000, up by 23% from the previous year's budget. Of those responding to the 1977 Citizens' Policy Survey, 70% of county residents residing outside of Gillette felt that county police protection needed improvement, and 79% of city residents felt that traffic control needed to be improved.

In 1973, the Gillette Police Department had 2.22 policemen per 1,000 city residents. The 1977 figure was 0.75 per 1,000, while the national average was 1.9 per 1,000, emphasizing the lag between rapid population growth and expanded city services. In addition, the turnover rate at the Gillette Police Department is very high, and is partially attributable to the cost of living in Gillette.

Water Supply

Gillette obtains its water supply from local wells tapping the Wasatch or Fort Union Formation. Surface water is not readily available in Campbell County, and it is not used as a domestic water source. Historically, the city's water supply has been inadequate for summer needs, and the water has been of poor quality, either being very hard, or soft with the smell of hydrogen sulfide. Of those residents of Gillette responding to the 1977 Citizens' Policy Survey, 80% felt that the water supply needed improvement, and 95% felt that the quality of the water needed improvement.

In order to reduce the impact of new subdivision approvals on the city's water supply system, Gillette began requiring that all new subdivisions provide well sites. In addition, in order to assure adequate financing to provide sufficient water in each new subdivision, the city increased tap fees from $250 plus costs to $950 plus costs.

During 1977, Gillette markedly improved its water supply system by (1) renovating its pretreatment water plant, (2) drilling two new soft water wells (costing $163,000) and renovating several abandoned water wells, and (3) tripling the city's water storage capacity for summer needs to 6 million gallons (costing $1.5 million). The city's water now undergoes lime softening, and degasifying before it is supplied to city residents. The 1978 Wyoming Legislature provided loans for the construction of pipelines to bring water to Gillette from wells drilled into the Madison Formation.

Waste Disposal

Gillette constructed a $4.19-million sewage treatment plant in 1974 that has a capacity of 1.4 million gallons of sewage per day. Funding was supplied by the Environmental Protection Agency (EPA) and distributed by the State of Wyoming. The Wyoming Department of Environmental Quality (DEQ) granted the city a discharge permit for the new plant in April 1974.

The plant is currently processing an average of 0.76 million gallons per day with peak loads approaching 1.4 million gallons per day. The city government has stated that the plant has been operating at capacity since 1975. During the summer of 1976, the city increased its sewer tap fee to $1,081 per residential tap in order to increase revenues.

Raw sewage, some of which presumably comes from outside of the city limits, can currently be disposed of at the city's sewage treatment plant, further impacting the plant's limited capacity. The city is considering drastically increasing the rates charged for disposal of the raw sewage in order to increase revenue and discourage use of the disposal service.

Of those residents of Gillette responding to the 1977 Citizens' Policy Survey, 63% felt that the city's sewage treatment needed improvement; however, 40% of the residents of mobile home parks and residential subdivisions in Campbell County felt that there was a critical need for improvement of sewage treatment facilities. Campbell County has experienced periodic health problems arising from the operation of marginally adequate sewage treatment facilities serving housing subdivisions in the unincorporated areas around Gillette, and the county administration is apparently developing countywide regulations to govern sanitation practices.

Solid waste from Gillette is placed in an 80-acre sanitary landfill project that is located on the southwestern edge of the city. The site can be utilized for another 5 or 6 years. The city has been unable to secure a future landfill site that meets federal and state regulations.

Industrial oil is apparently being illegally dumped into the city's sewer system, adversely affecting the biological treatment system used at the sewage treatment plant. Neither the city nor the county currently provides facilities for disposal of industrial oil.

Medical Facilities

The Campbell County Memorial Hospital, with a capacity of approximately 30 beds and newly improved emergency room facilities, is located in Gillette. The Northeast Wyoming Regional Medical Center and the Medical Center of Campbell County are also located in Gillette. Medical service in Campbell County is provided by nine doctors; there are thus 1,778 patients for every practicing physician.

Of those Campbell County residents responding to the 1977 Citizens' Policy Survey, only 6% indicated that local medical service is adequate while 60% felt that there was a critical need for improved service. Until recently, local medical service was critically understaffed. Some overworked doctors left the county, and service was often difficult to obtain. Many dissatisfied residents apparently obtained medical service outside the county. The Campbell County Hospital Board successfully recruited five doctors during the fall and winter of 1977, reducing the doctor shortage. The goal of the hospital board is to eventually have one doctor per 1,000 residents.

The residents of Campbell County passed an $8.5 million bond issue June 23, 1976 for construction of a new county hospital. Construction of the 55-bed facility began during the fall of 1977, but completion of the facility will not occur for several years.

Although existing medical facilities and service have been impacted by rapid population growth, improvement of both the facilities and service did occur during 1977.

Education

Classroom space and number of teachers are currently adequate in Gillette.

The Private Sector

Introduction

Boom-town conditions also affect the private sector of the local economy. Services, such as motels, restaurants, and retail stores, are often overwhelmed by local population growth. Local lending institutions are often hard pressed to finance local private sector expansion. Uncertainty about future developments causes investors to be wary.

Housing

Normally, increases in economic activity and population growth are signs of opportunity to the housing industry. Increased housing demand is expected to stimulate increased housing production in roughly the quantity of units, the mix of unit types, and the price ranges demanded. However, in Gillette increased housing demand has come in difficult-to-predict waves to a geographically isolated community, which did not have a well-developed housing industry to begin with. The result has been a series of mutually reinforcing problems.

Single-Family Homes. A recent opinion poll in Campbell County found that 85% of all respondents desired to live in single-family homes (1977 City of Gillette/Campbell County Citizens' Policy Survey). There is evidence that as the mining work force in Campbell County shifts from construction workers to permanent workers, and as more construction workers view their stay in Gillette as long term, this preference for single-family homes can be expected to increase.

The local housing situation is not able to satisfy these preferences. Table BU2-8 describes the existing housing stock in the county. About 30% of the available dwellings are single-family units. The majority of these units are several years old, and located within the city of Gillette. Fifty-four percent of the housing stock is mobile homes, mostly recent additions located just outside the city limits. Table BU2-9 shows the changes in the housing stock since 1970. Only 30% of the new housing in Gillette is single family.

The overall cost of housing in Gillette is presently estimated to be 17% higher than in nearby Sheridan, 19% higher than in Wyoming communities in general, and 23% higher than the Denver metropolitan area, which serves as the regional financial center (Wyoming Department of Labor and Statistics 1977). This, however, may be understating the difference in price for new dwellings of common size and quality of construction. Developers who market similar houses in both Gillette and the Denver metropolitan area indicate that costs of production are 30% higher in Gillette than in Denver. New single-family units in Gillette, whether modular or conventionally constructed, are seldom priced at less than $46 per square foot. For most builders, the "bottom of the line"is a 1,100-square-foot home for roughly $51,000.

The reason for this price differential is found in the developer's costs. As a result of land speculation, finished

TABLE BU2-8

EXISTING HOUSING STOCK IN CAMPBELL COUNTY, JULY 1977

Type of Dwelling Unit	City of Gillette Number	City of Gillette Percent	Remainder of Campbell County Number	Remainder of Campbell County Percent	Totals Number	Totals Percent
Single-Family	1,623	42.3	515	15.9	2,138	30.1
Rural Dwellings	0	0	396	12.2	396	5.5
Duplexes (no. of units)	181	4.7	8	0.2	189	2.6
Multi-Family (no. of units)	499	13.0	28	0.9	527	7.4
Mobile Homes (in parks)	1,154	30.0	1,805	55.6	2,959	41.8
Mobile Homes (outside parks)	378	9.8	494	15.2	872	12.3
Total	3,835		3,246		7,081	

Source: City of Gillette/Campbell County Department of Planning and Development 1978; U.S. Department of Commerce, Bureau of the Census 1972.

TABLE BU2-9

CHANGES IN THE HOUSING STOCK, 1970-1977

	Total Units 1970	1977	Net Change 1970-1977	Percent of the Increase of New Housing Stock 1970-1977
Gillette				
Single-Family	1,139	1,623	484	30
Duplexes (no. of units)	165	181	16	Less than 1
Multi-Family (no. of units)	279	499	220	14
Mobile Homes	645	1,532	887	55
Total	2,228	3,835	1,607	
Campbell County (including Gillette)				
Single-Family	1,782	2,138	356	19
Duplexes (no. of units)	172	189	17	Less than 1
Multi-Family (no. of units)	318	527	209	11
Mobile Homes	1,644	2,959	1,315	69
Total	3,916	5,813	1,897	

Source: U.S. Department of Commerce 1972, City of Gillette/Campbell County Department of Planning and Development 1978, Denver Research Institute 1977.

lots may cost $7,500 to $14,000 before tap fees (25% to 40% higher than in the Denver area). Facing financial difficulties of its own, the City of Gillette is charging approximately $2,100 for water and sewer tap fees (considerably higher than in the Denver area). Plumbing subcontracts may cost $2,000, or more, per unit (50% to 100% higher than in the Denver area). Carpentry labor may cost $7.00 to $12.00 an hour (8% to 85% more than in the Denver area where the union wage is $6.50 an hour).

Thus far, with single-family units comprising such a small portion of the available housing stock, it has been a sellers' market. Houses priced below $60,000 are usually sold before construction is completed.

Inflated housing production costs have placed the goal of a single-family dwelling beyond the reach of many newcomers. At prevailing conventional mortgage terms, a household would require almost $7,000 in cash and a $22,000 annual income in order to purchase a $55,000 home. (The most common terms are 9¼% to 9½% (including ¼% for private mortgage insurance) for 30 years, with a 10% down payment. In addition to the down payment, closing costs average $1,300. Most lending institutions require that principal and interest payments not exceed 25% of a household's gross monthly income, or that its total debt liabilities not exceed 30%. Using a 9½% interest rate and the 25% rule, for a $55,000 home; the annual income requirement would be $21,780.) By regional standards, wages in Campbell County are excellent. Mining wages average $19,700 per year; all other occupations combined average $14,400 per year (personal communication, Wolford, Employment Security Commission of Wyoming 1977). Nevertheless, most households are unable to afford a single-family house unless they have more than one full-time wage earner.

Mobile Homes. As Tables BU2-8 and BU2-9 indicate, mobile homes are the most prevalent and the fastest growing housing alternative in Campbell County. Sixty percent of the increase in housing since 1970 has been in mobile homes. Presently, 67% of the housing in the county outside Gillette is mobile homes.

Mobile homes, including campers, are the most common alternative for those who would have preferred single-family dwellings. While they are by no means inexpensive, mobile homes are priced at a level within the reach of most local households. The typical purchase requires $1,800 in down payment and an annual income of $7,200. Typical principal and interest payments are $150 per month. Many households presently living in mobile homes hope to use them as "starter homes,"to sell their mobile homes and use the equity to purchase single-family dwellings.

Thus far, mobile homes have worked well as starter homes. Rapid increases in housing demand and inflation in the cost of new mobile homes have resulted in high resale value for existing units. Units have tended to appreciate in value, which is contrary to the national pattern. However, planners are concerned that over the next decade, large numbers of mobile homes will deteriorate in physical condition, since their life span is much shorter than that of traditionally constructed dwelling units.

Conditions have changed since the initial phase of Gillette's housing boom when mobile home parks were an attractive investment. While banks and private mortgage companies have been successful in packaging and selling home mortgages to the secondary mortgage market, there is still an acute shortage of local commercial credit. As a consequence, local loans for all but the most favorable new business ventures, which presently excludes new mobile home parks, are difficult to obtain.

There is already a shortage of mobile home spaces in and around Gillette. Barring further housing development initiatives by the coal companies, it is likely to get worse. Anti-mobile home sentiment already exists among bankers and community leaders; consequently, their support of plans to increase the number of mobile home lots will probably be minimal.

Multi-Family Units. As Table BU2-9 indicates, less than 10% of the new dwelling units in the county have been duplexes or multi-family units. For the most part, these have been rental units. There is a great need for more rental units. The Gillette Chamber of Commerce has recently begun a rental referral service to assist newcomers in finding apartments. It has far more requests for referrals to rental units than it can fill.

As with mobile home parks, the main reasons for this shortage are the relatively high level of risk associated with new apartment developments and the shortage of local commercial credit. The risks to commercial lenders for apartments are seen as particularly high since initial capital investment is high and apartment vacancy rates are dependent on such a large number of variables. Actions by coal companies to improve housing conditions, such as subsidies of single-family units, could have the side effect of decreasing the demand for apartments.

Partially because of increased business activity and partially because of the shortage of long-term rental units, there is also a shortage of transient quarters. Many newcomers find themselves forced to live in motel rooms for long periods of time while searching for other housing alternatives. Unfortunately, motel space is also in extremely short supply.

FUTURE ENVIRONMENT

If the proposed mining does not take place, and if Shell Oil does not sell or use the land surface for a purpose other than coal mining, the project area would continue to exist in its present condition, subject to modification by natural processes, or the continuation of existing uses, including approved coal mines in the vicinity. The project area may be subject to increased casual use by hunters, off-road vehicle users, and collectors due to increased regional population; since the land is privately owned, such use would be restricted. Local transportation improvements would continue as planned without approval of the Buckskin Mine (see regional analysis, Chapter 8, Low-Level Scenario, Transportation Networks). Socioeconomic impacts of the same type and virtually the same magnitude would occur in the region with or without the proposed mine. See regional analysis, Chapter 4, Socioeconomic Conditions, for a complete discussion of regional and local effects of mineral development.

CHAPTER 3
ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

INTRODUCTION

The analysis developed in this chapter is an assessment of impacts that would result from development of coal on the proposed Buckskin project. Impacts are quantified by time periods 1980, 1985, 1990, and end of mine life. Quantification may be stated as an increment for the time period or as a cumulative total at the end of each time period. The method of quantification that best describes the impact will be used.

Mining and reclamation plans for the proposed Buckskin Mine, as well as for mines currently operating or pending approval and already under study in separate environmental statements (ESs), were submitted prior to passage of the Surface Mining Control and Reclamation Act of 1977 (SMCRA), PL 95-87. Therefore, the plans may not reflect all the requirements of the law. All plans must be modified by the respective companies to meet SMCRA requirements. In the case of Buckskin, prior to final approval of the authorizing agencies, the modified plan will be reevaluated to insure (1) that it satisfies the requirements of SMCRA and the resultant federal regulations, and (2) that the potential impacts of mining have been covered by environmental analysis. This procedure will allow timely consideration of Shell's application to mine (which is complete in other respects), while the requirements of SMCRA are still evolving.

Chapter 3 of the regional analysis, Planning and Environmental Controls, refers to provisions of SMCRA which are applicable to the coal mining in the region. These were considered in the following impact analysis to the extent possible. However, some of the impacts described may be precluded by eventual implementation of the new law.

ANALYSIS GUIDELINES

An analysis of impacts requires establishing guidelines for coal-related development. The following narrative and tables were developed to establish such guidelines for the proposed Buckskin project.

Guidelines

1. Impacts are analyzed for four time points (1980, 1985, 1990, and end of mine life).
2. Reclamation on an area is considered complete when disturbed lands have been backfilled, graded, contoured, revegetated, approved, and bond is released in accordance with an approved reclamation plan (Wyoming Land Quality Rules and Regulations 1975, and the Surface Mining Control and Reclamation Act of 1977).
3. Any impacts lasting after closure of the mine and release of bond will be considered long-term impacts.
4. Acreage and water requirements are assumed using guidelines set forth in Table BU3-1, unless the information is specified by the applicant.

The following tables are presented to provide an overview of total land disturbance that would occur by the development of the Buckskin project. Table BU3-2 portrays the areas of land disturbed and reclaimed during each designated time period by various activities related to the project. Table BU3-3 portrays the disturbance and reclamation of the same acreage as cumulative totals for each time period by activities.

CLIMATE

It is not expected that mining activities at the proposed Buckskin Mine site would affect precipitation. Possible changes in the radiation balance due to changes in the character of the soil would be undetectable. The alteration of the terrain may change onsite wind patterns, but this impact would be undetectable beyond a local level. The extent to which onsite updrafts increase or decrease in intensity would be difficult to determine; however, any changes would probably be insignificant.

AIR QUALITY

Emissions from the Proposed Mine

Nine major sources of fugitive dust would be associated with the proposed mine: haul road traffic, shovel/truck loading, blasting, truck dumping, drilling, topsoil removal, front-end loading, access road traffic, and wind erosion from exposed areas. Two point sources would be the coal crusher and the load-out facility. Table BU3-4 lists these emissions sources and the corresponding emission factors.

The annual emissions from the proposed site (Table BU3-5) were calculated using the emission factors listed in Table BU3-4. The operational parameters were obtained from the mining and reclamation plan and personal communications with mining representatives. Emission

TABLE BU3-1

Acreage Requirements

Facility	Approximate Acres Required
Power line	6 per mile
Railroad spur (100-foot right-of-way)	12 per mile
Roads (100-foot right-of-way)	12 per mile
Population increase	100 per 1,000 people
Coal mining (includes mine facilities, ancillary facilities)	140 per mine

Water Requirements

Facility	Acre-Feet
Per 1,000 population increase (urban)	190 per year*
Mine operations	20 per million tons coal**

* Based on present water use by the city of Gillette.

** ES team estimate

TABLE BU3-2

Acreage Disturbed by Activity and Acreage Reclaimed Over Periods of Time (Noncumulative)

ACTIVITY	TIME PERIODS 1980	1985	1990	1990+*	TOTAL
Mining	21	236	120	281	658
Mine facilities	140	0	0	0	140
Access road**	72	0	0	0	72
Railroad Spur***	72	0	0	0	72
Stockpiles****	129	0	0	0	129
Subtotal	434	236	120	281	1,071
Population*****	45	0	0	0	45
Total	479	236	120	281	1,116
Acres Reclaimed	0	0	14	1,057	1,071

* To end of mine life which is estimated to be the year 2000.
** 200-foot right-of-way with 100-foot usable width.
*** 100-foot right-of-way.
**** Topsoil stockpiles in continual use, years -2 to 21, no breakdown attempted. Overburden stockpiles are within the mining area.
***** Assumed using Table BU3-1.

TABLE BU3-3

Acreage Disturbed by Activity and Acreage
Reclaimed Over Periods of Time
(Cumulative)

ACTIVITY	TIME PERIODS 1980	1985	1990	1990+*
Mining	21	257	377	658
Mine facilities	140	140	140	140
Access road**	72	72	72	72
Railroad spur***	72	72	72	72
Stockpiles****	129	129	129	129
Subtotal	434	670	790	1,071
Population*****	45	45	45	45
Total	479	715	835	1,116
Acres Reclaimed	0	0	14	1,071

* To end of mine life which is estimated to the year 2000.
** 200-foot right-of-way, with 100-foot usable width.
*** 100-foot right-of-way.
**** Topsoil stockpiles in continual use, years -2 to 21, no breakdown attempted. Overburden stockpiles are within the mining area.
***** Assumed using Table BU3-1.

TABLE BU3-4

FUGITIVE AND POINT SOURCES IDENTIFIED AT THE PROPOSED MINE WITH CORRESPONDING EMISSION FACTORS

Emission Source	Emission Factor
FUGITIVE:	
1. Haul Roads	4.3 lb/vehicle mile traveled
2. Shovel/Truck Loading	
a. Coal	0.0035 lb/ton loaded
b. Overburden	0.037 lb/ton loaded
3. Blasting	17 tons/1,000,000 tons of coal mined
4. Truck Dumping	
a. Coal	0.007 lb/ton dumped
b. Overburden	0.002 lb/ton dumped
5. Drilling	
a. Coal	0.22 lb/hole drilled
b. Overburden	1.5 lb/hole drilled
6. Topsoil Removal	
a. Scraping	0.35 lb/cubic yard scraped
b. Dumping	0.03 lb/cubic yard dumped
7. Front-end Loading	0.12 lb/ton of coal loaded
8. Access Road Traffic	5.16 lb/vehicle mine traveled*
9. Exposed Areas (wind erosion)	0.4 ton/acre/year**
POINT SOURCES:	
1. Coal Crusher	0.005 lb/ton crushed
2. Load-Out Facility	0.0002 lb/ton loaded

Source: PEDCo Environmental, Inc. 1978a, except as noted.
* Calculated from formula in U.S. Environmental Protection Agency 1976a.
** Calculated from formula by Midwest Research Institute 1974.

TABLE BU3-5

ANNUAL EMISSIONS FROM THE PROPOSED BUCKSKIN MINE SITE

Emission Source	Tons per Year 1980	1985	1990	1999*
FUGITIVE DUST				
1. Haul Roads (with watering)	262	575	664	333
2. Shovel/Truck Loading	28	134	147	122
3. Blasting	68	68	68	68
4. Truck Dumping	15	21	22	20
5. Drilling	2	4	4	4
6. Topsoil Removal	55	47	39	107
7. Front-End Loading	24	24	24	24
8. Access Roads	206	206	206	206
9. Exposed Areas (wind erosion)	101	95	100	94
10. Load-Out Facility	<1	<1	<1	<1
11. Crusher	1	1	1	1
TOTAL FUGITIVE DUST	763	1,176	1,276	980
GASEOUS POLLUTANTS				
1. Vehicles				
Carbon Monoxide	6.2	9.0	6.2	3.6
Hydrocarbons	0.7	0.8	0.7	0.4
Nitrogen Oxides	1.6	3.4	1.7	1.0
Sulfur Oxides	0.3	0.8	0.9	0.5

* Last active year of mining.

inventories were performed for the mining years of 1980, 1985, 1990, and 1999, which would be the last active year of mining. These inventories are the best approximations of the complex interaction of variables.

The only potential air pollution source identified at the Buckskin Mine site other than fugitive dust sources would be exhaust emissions from diesel-powered haul trucks and from employee motor vehicles on mine access roads. Emission factors for vehicular travel were obtained from the Environmental Protection Agency's (EPA's) most recent compilation of mobile source emission factors, and they reflect current legislation relative to future emission standards in high altitude areas (EPA 1978).

Estimated emissions of carbon monoxide (CO), hydrocarbons (HC), oxides of nitrogen (NO_x) and sulfur oxides (SO_x) are shown in Table BU3-5. These emissions are from both employee travel on the mine site and haul trucks.

Emission rates shown in the table reflect the measures proposed by Shell Oil Company in its mining and reclamation plan.

Impact on Air Quality

The impact of the above annual emissions on the nearby ambient total suspended particulate (TSP) concentrations was determined by use of the Modified Climatological Dispersion Model-Version 3 (MCDM-V3) (PEDCo Environmental, Inc. 1976). The model performs both annual averaging and worst-case 24-hour periods. Source data input consists of the following: source locations; source emission rates; emission heights; locations where ground-level pollutant estimates are desired; frequency of occurrence of each of sixteen wind directions, six wind speeds, and six stability classes; and particulate fallout functions. Climatological data were collected at the Moorcroft weather station, because the weather station at Gillette does not have a stability rose (STAR) data deck compiled. The STAR data is necessary for modeling ambient air concentrations of pollutants from the mine.

Figures BU3-1 through BU3-4 show the annual predicted and resulting ambient TSP concentrations for the years 1980, 1985, 1990, and 1999, as determined by the model. Figures BU3-5 through BU3-8 show the worst-case 24-hour predicted and resulting ambient TSP concentrations for the same years. Concentrations in both situations are shown to decrease rapidly with distance.

Figures BU3-1 through BU3-4 show there would be no violations of the annual Wyoming state standard of 60 micrograms per cubic meter ($\mu g/m^3$) beyond the boundary of the proposed mine site for all four study years. The exception to this would be the air quality in close proximity to the access road as a result of employees arriving at and leaving the mine each work day. However, 0.3 miles from the access road, annual concentrations may be violated northwest and southeast of the mine site as a result of predominant wind directions, but even in these areas, resulting ambient TSP concentrations would decrease rapidly such that impact from the proposed facility would be essentially negligible (10 $\mu g/m^3$) 2.2 miles from the mine property boundary.

Figures BU3-5 through BU3-8 indicate that no violations of the worst-case 24-hour Wyoming state standard of 150 $\mu g/m^3$ would occur beyond the mine boundary. As was the case with annual concentration, the exception would be air quality in close proximity to the access road. However, no violations would occur beyond 0.3 miles from the access road.

Note that the above TSP violations include the fugitive dust generated by the mine and vehicular traffic. Because the new prevention of significant deterioration of air quality regulations (43 CFR 118) exclude most of these emissions, no violations would occur. In fact, air quality at the mine would be well within the applicable national ambient air quality standards.

Gaseous Pollutants

Vehicle emissions would be the only source of gaseous air pollutants from the proposed facility. Predicted concentrations of these pollutants were not modeled due to the lack of detailed data on vehicle use and applicable background data. However, recent studies (U.S. Department of the Interior 1976) on the impact of vehicle emissions associated with western coal mines estimate the probable range of impact to be insignificant. Assuming similar vehicle activity for the proposed mine, ambient concentrations of gaseous pollutants would be minimal and insignificant compared to their respective standards.

Visibility

The addition of particulates to the atmosphere would reduce visibility in the area. However, considering the extremely low predicted concentrations from the proposed facility, no perceptible visibility changes would be anticipated. Visibility would be expected to continue to exceed 60 miles at times and average between 26 to 47 miles, depending on climatological conditions such as fog, rain, or snow.

TOPOGRAPHY

During mining, the topography at the proposed mine site would be characterized by open pits, steep slopes, spoil piles, and haul roads.

When mining is completed, backfilling and grading efforts would restore the topography to a large, smooth-sloped, open-ended depression with new drainage patterns as shown on Figure BU3-9. When reclamation is completed in 2001, Shell estimates that the topography would be an average of 75 feet lower than it is now.

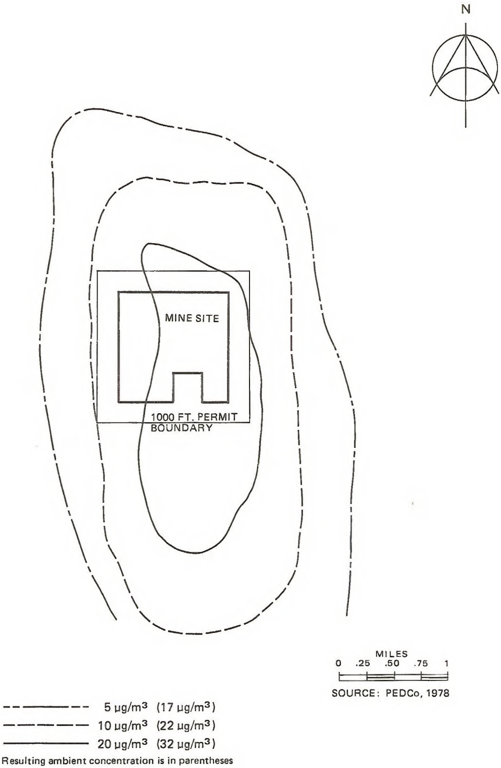
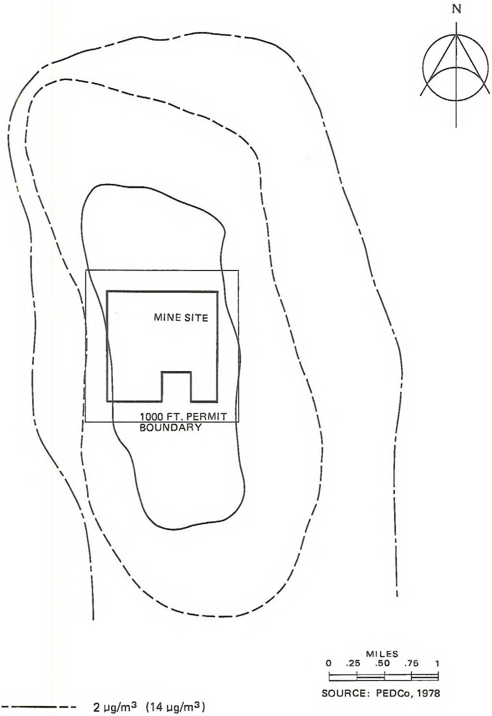


Figure BU3-1

ISOPLETH DIAGRAM SHOWING ANNUAL PREDICTED AND RESULTING AMBIENT PARTICULATE CONCENTRATIONS FOR 1980



SOURCE: PEDCo, 1978

- - ———— - - 2 µg/m³ (14 µg/m³)
— — — — — — 5 µg/m³ (17 µg/m³)
———————— 10 µg/m³ (22 µg/m³)

Resulting ambient concentration is in parentheses

Figure BU3-2

ISOPLETH DIAGRAM SHOWING ANNUAL PREDICTED AND RESULTING AMBIENT PARTICULATE CONCENTRATIONS FOR 1985

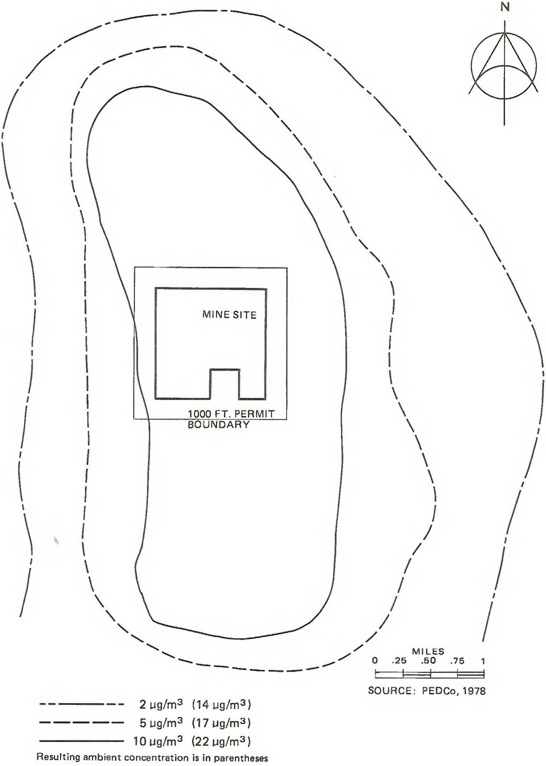


Figure BU3-3

ISOPLETH DIAGRAM SHOWING ANNUAL PREDICTED AND RESULTING AMBIENT PARTICULATE CONCENTRATIONS FOR 1990

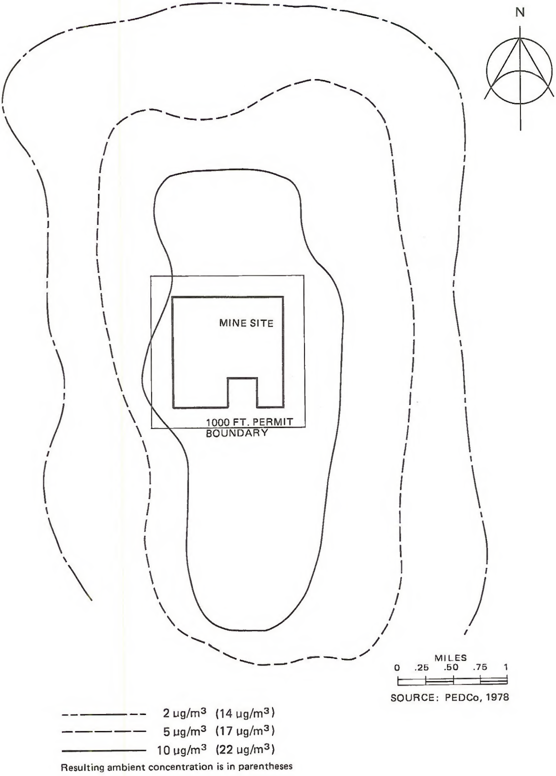


Figure BU3-4

ISOPLETH DIAGRAM SHOWING ANNUAL PREDICTED AND RESULTING AMBIENT PARTICULATE CONCENTRATIONS FOR 1999

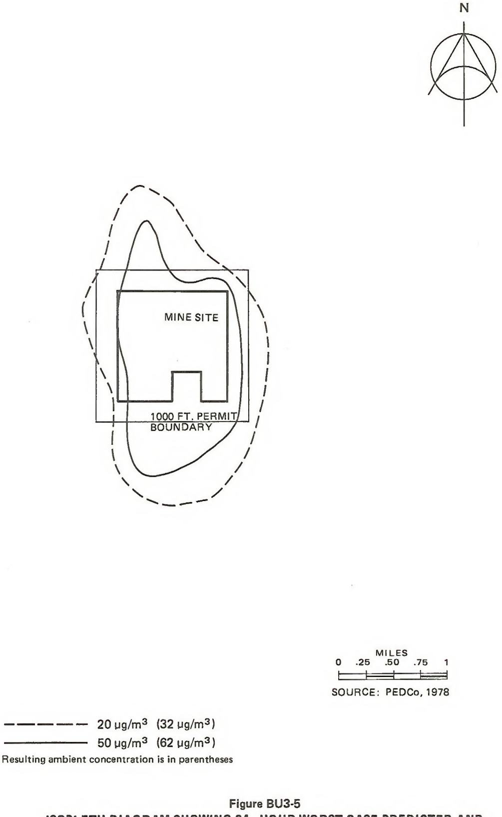
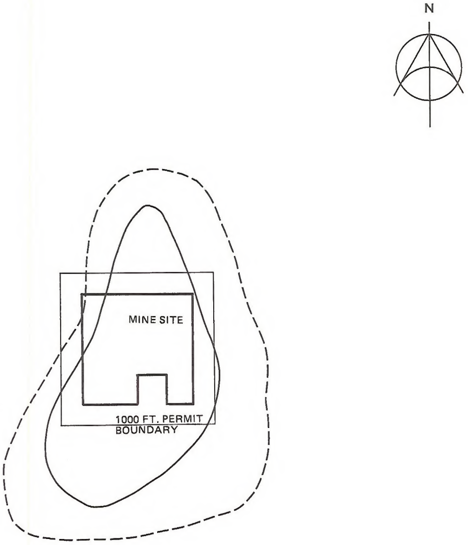


Figure BU3-5

ISOPLETH DIAGRAM SHOWING 24 - HOUR WORST CASE PREDICTED AND RESULTING AMBIENT PARTICULATE CONCENTRATIONS FOR 1980



MILES
0 .25 .50 .75 1

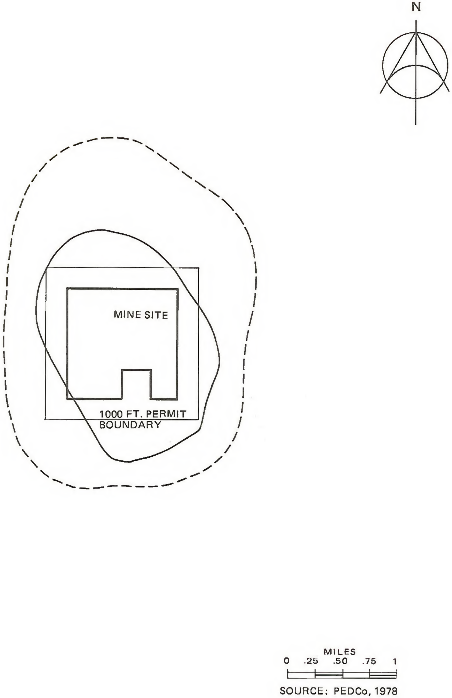
SOURCE: PEDCo, 1978

- - - - - - 15 μg/m³ (27 μg/m³)
———— 30 μg/m³ (42 μg/m³)

Resulting ambient concentration is in parentheses

Figure BU3-6

ISOPLETH DIAGRAM SHOWING 24 - HOUR WORST CASE PREDICTED AND RESULTING AMBIENT PARTICULATE CONCENTRATIONS FOR 1985



– – – – – – 20 μg/m³ (32 μg/m³)

———— 50 μg/m³ (62 μg/m³)

Resulting ambient concentration is in parentheses

Figure BU 3-7

ISOPLETH DIAGRAM SHOWING 24 - HOUR WORST CASE PREDICTED AND RESULTING AMBIENT PARTICULATE CONCENTRATIONS FOR 1990

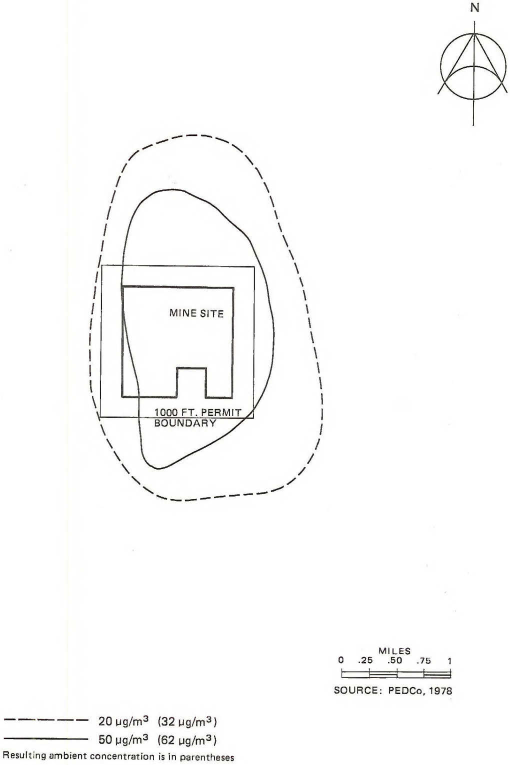
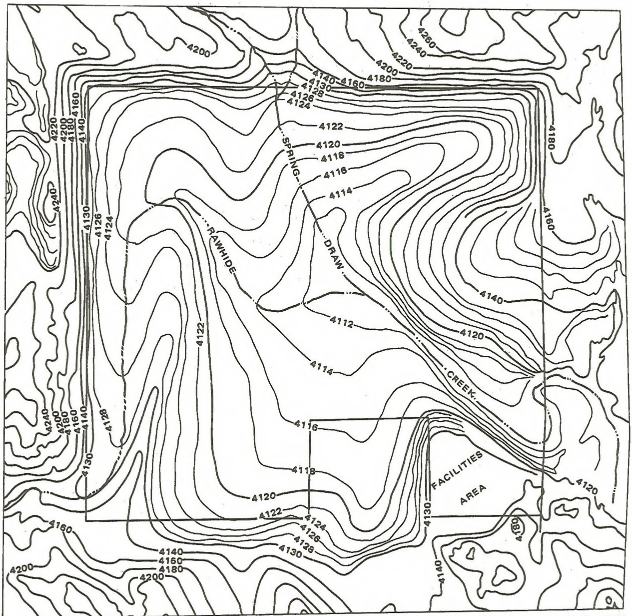


Figure BU3-8
ISOPLETH DIAGRAM SHOWING 24 - HOUR WORST CASE PREDICTED AND RESULTING AMBIENT PARTICULATE CONCENTRATIONS FOR 1999



MODIFIED FROM SHELL OIL COMPANY, 1977

Figure BU3-9
TOPOGRAPHY OF THE MINE SITE AFTER RECLAMATION

GEOLOGY

Strip mining at the Buckskin Mine would result in the loss of the geologic record. On the area which would actually be mined, an average of 208 feet of strata, including the coal, would be lost over an area of 21 acres by 1980, 257 acres by 1985, 377 acres by 1990, and ultimately 658 acres by the end of mine life. In addition to physical loss of strata, about 2 miles of contacts between the coal and the overlying and underlying formations, which are the basis for geologic mapping, would be covered by fill and thus lost to future observation and study. A beneficial impact would be exposure of geologic sections during mining that would otherwise never have been available for scientific examination.

About 1½ miles of alluvial valley floor, as defined by the Surface Mining Control and Reclamation Act, would be disturbed (see Figure BU2-4).

Because replaced spoil settles over time, ground stability is altered where surface mining has occurred. Ground stability would be altered to an average depth of 125 feet over an area of 658 acres by 2001 when reclamation is complete. This could affect both future construction on and seismic exploration for deeper mineral resources through the reclaimed fill (see Chapter 4, Geology, of the regional analysis).

Considering the small percentage of area that would be disturbed at the site compared to the total Eastern Powder River Basin (.01% by 2001), both loss of geologic record and decreased ground stability seem insignificant.

Paleontology

Potential fossil-bearing formations that would be affected by mining are the two coal seams and a few feet of interburden (totaling about 107 feet) at the top of the Fort Union Formation, as much as 215 feet at the lower part of the Wasatch Formation, and all Quaternary deposits. Paleontological loss would probably include pollen and plants, especially in association with the coal, and possibly some invertebrates and vertebrates in the Fort Union and Wasatch formations. Plant remains are relatively abundant in both these formations. Invertebrate and vertebrate remains that might be uncovered would not have been available for scientific examination prior to mining.

Quaternary fossils, both invertebrate and vertebrate, could be disturbed or lost at the site during overburden removal. Fossils of these ages are often discovered by excavating operations—road and dam building, gravel pits, etc.—and it is possible that mining operations could result in discoveries of Quaternary fossils.

Paleontological material throughout the region could be lost due to increased unauthorized fossil collecting and vandalism as a result of increased regional population. The extent of this impact cannot be presently assessed due to a lack of specific data on such activities.

Due to the present lack of data and accepted evaluatory criteria for determination of significance, no meaningful assessment can be presently made as to the extent and nature of the loss of these paleontological values to science or education, or hence to the significance of potential impacts on the fossil record.

SOILS

All developments (surface mining facilities, access road, railroad spur, and population increases) would cumulatively disturb soils on 715 acres by 1985; 835 acres by 1990; and 1,116 acres by the end of mine life (2000). The disturbance on 1,071 acres would be of a temporary nature, since the land would eventually be reclaimed. The loss of soil productivity would be permanent on 45 acres by the end of mine life.

Mining activities would impact soils by alteration of existing soil properties through disturbance and mixing of soil. These properties include soil microorganism composition, structure, texture, organic matter content, infiltration rate, permeability, water-holding capacity, nutrient level, soil-climatic relationships, and productivity that have developed over geologic time (Brady 1974, U.S. Department of the Interior 1975, 1976a). Stockpiling surface material would degrade biological, chemical, and physical properties, causing reductions in productivity when used in reclamation (Monsen 1975). The established levels of soil productivity would be lost and would not fully recover to present levels in the long term based on analysis of the Buckskin site.

Mining could expose material which contains chemical constituents (such as selenium, boron, or uranium) that would be harmful to plants and animals. These materials could exist in the overburden material. According to drilling logs and overburden analyses, these materials are absent or present in very low amounts on the Buckskin site. This data seems reasonable in light of other information collected in the region. Other soil materials found in the area that would hamper reclamation include those of high alkalinity or salinity; sand or clay-textured material; and material with low cation exchange capacities (see Chapter 2 for identification of these soils).

Accidental spills of oil, gasoline, and other toxic materials could contaminate and sterilize the soil horizons, rendering the affected soil unusable for reclamation, but these occurrences would be localized and of little relative significance. Any such contaminated material would be buried as required by the Surface Mining Control and Reclamation Act (SMCRA).

An accelerated rate of wind erosion would occur on areas disturbed and being reclaimed, where vegetative cover is absent. The amount of annual soil loss to wind erosion from the Buckskin site after mining begins would range from 85 to 110 tons, which is an increase of 70 to 90 tons per year over erosion rates from the undisturbed site.

Between the time the land is reshaped during reclamation and the time when vegetation is reestablished, soil would be subject to an accelerated rate of water erosion. The rate of water erosion on areas with recently redistributed topsoil would range from 10 to 30 tons per acre

per year (calculated using Musgrave's Equation, Bureau of Land Management Manual 7317.22A) depending on such variables as slope and climatic conditions. This is an increase of 5 to 25 tons per acre per year over rates for undisturbed land.

If a 10-, 25-, 50-, or 100-year flood were to occur when areas are in the process of being reclaimed, additional erosion would occur, resulting in large amounts of soil loss and postponement of successful revegetation.

Reclamation of surface mining and associated facility areas would cumulatively occur on an estimated 790 acres by 1990 and an estimated 28 acres yearly thereafter (refer to Table BU1-3). Suitable topsoil material, steep slopes, aspect, surface manipulations, and climate are important variables of reclamation success. The limited amount of good to fair soil material, moderately steep slopes, and soils that are poor for reclamation are evident on the Buckskin project in a number of mapping units (refer to Chapter 2, Soils).

During reclamation, topsoil would be evenly spread over the disturbed areas. Thus, areas deficient in topsoil prior to mining would gain topsoil from sources with a surplus. The result would be some increase in soil productivity in these deficient areas but not enough to offset reduction of soil productivity on the major portions of disturbed acreage.

In all likelihood, based on reclamation efforts at nearby sites in Montana and Wyoming, there would be a strong response by seeded vegetation on the reclaimed area during the first decade or two after reclamation, if climatic conditions are average or above average during this period. The ground cover of living plants on the revegetated area should equal or exceed 90% of the ground cover of the reference area (a control plot of undisturbed ground) for more than two growing seasons during these early years as required under regulations of the Surface Mining Control and Reclamation Act. However, there would probably be a long decline in productivity in later decades as the vigor of the planted species declines on the overall thinner soil than existed prior to mining (see Table BU3-8). Since there are few soil-forming processes going on in the Powder River Basin under today's climate, overall soil productivity on the Buckskin site in later decades would remain at 94% of premining productivity for an indefinite future period.

The quality and quantity of "topsoiling"material and change in soil productivity after reclamation are quantifiable through the land capability and range site systems. The land capability and range site classification systems are nationally accepted methods for determining agricultural land potential prior to major disturbance, such as mining.

The use of these systems in analyzing the Buckskin reclamation plan is based on the assumption that the restored landforms and recreated soils will perform like soils which occur naturally in the existing environment. This assumption has not been proved or disproved on mined land as yet due to the short time period that these systems have been applied to mined lands.

The calculation of postmining productivity requires an assessment of the existing natural soils to determine how many acre-feet of suitable material are available for reclamation use (see Tables BU3-6 through BU3-8). Our analysis, using these systems, indicates that *long-term* soil productivity on the Buckskin site would be 94% of premining productivity. We therefore disagree with Shell's contention that they can recreate 100% soil productivity.

For a more complete discussion of the land capability and range site systems, see Chapter 2, Soils, of the regional analysis.

WATER RESOURCES

Groundwater

The assessment of impacts on groundwater is based on a mine plan written before enactment of the Surface Mining Control and Reclamation Act of 1977. Alluvial valley floors as defined by the act occur on the leasehold; therefore, stripping of the floors would have to comply with the standards established by the act.

Two types of impacts would result from mining: those that are a direct result of mining and those that occur after reclamation. Impacts related to mining are those caused by the removal of existing aquifers and the increased use of groundwater by industry and municipalities.

The shallowest aquifers, or potential aquifers, in the area are the alluvium, overburden, and coal. These would be removed during mining, and water levels in adjoining, undisturbed beds would be lowered as the mine would become a discharge point. The groundwater flow into the mine predicted by the applicant is reproduced in Table BU3-9. Two of the assumptions on which the flow was estimated are that the cone of depression in the coal would extend approximately 3 miles, and that the cone of depression in the sandstone (overburden) aquifer would extend 1,000 to 1,500 feet. Approximately 40,000 gallons per day of the flow would be required for dust suppression. The remainder of the inflow would be pumped into Rawhide Creek (or its bypass channel) via settling ponds. The quality of water pumped into Rawhide Creek would be the same as that of the groundwater (see Tables BUA-1 through BUA-5 in the Appendix). The present quality of water in Rawhide Creek is compared with applicable standards in Table BUA-6, Appendix.

Additional groundwater supplies would be developed for potable water (4,655 gallons per day (gpd)), fire protection, and plant water (55,000 gpd). Increased water use of about 100,000 gpd during the life of the mine is expected. The water for potable supply would probably be from the Fort Union Formation. The cone of depression around the well would be negligible because of the small quantity of water required (less than 5 gallons per minute). The fire protection and plant water probably would be drawn from the same well, but a deeper well in the Lance Formation and Fox Hills Sandstone could be used. Withdrawal of water for fire protection and plant uses would not affect public or domestic supplies,

TABLE BU3-6

VOLUME AND QUALITY OF TOPSOIL MATERIALS BEFORE MINING

Series	%	Acreage	Topsoil Volume (acre-feet) Good	Fair	Poor
Arvada	6	64		21	299
Bankard	3	32		0	160
Bowbac	36	387	127	903	
Haverson	6	64	32	224	64
Olney	19	203		879	0
Renohill	9	96		48	144
Shingle	7	75	25		98
Samsil	7	75		30	63
Rock Outcrop	7	75	---	-----	---
	100	1,071	184*	2,105*	828*

* A total of 3,117 acre-feet of good, fair, and poor "topsoil" exists on the mine site, of which approximately 70% is recoverable. This yields 2,182 acre-feet of "topsoil" to be spread over entire reclaimed area or 2 feet of "topsoil" over the entire reclaimed area. "Topsoil" as used in this analysis refers to both the surface soil and subsoil, that is, the A, B, and usually the C horizons in soil morphological terms. Approximately 70% of the "topsoil" is considered recoverable due to the undulating nature of the contact between soil material and overburden and the usual result when the soil salvage operation is carried out with large machinery.

TABLE BU3-7

LAND CAPABILITY AND RANGE SITE COMPARISON

Land Capability Classification	Acres Present	Acres After Reclamation
IV	96	
VI	750	1,071
VII	150	
VIII	75	
Total Acres	1,071	1,071

Range Site	Present	After Reclamation
Clayey	96	
Lowland	96	
Sandy	590	
Saline	64	
Shallow clayey	75	
Shallow loamy	75	1,071
Rock outcrop	75	
Total Acres	1,071	1,071

TABLE BU3-8

POTENTIAL FORAGE PRODUCTION AT PRESENT

Range Site	Yield (lb/ac/yr)*	Acres	Total Yield (lb/yr)**
Clayey	1,300	96	124,800
Lowland	2,500	96	240,000
Sandy	1,600	590	944,000
Saline lowland	500	64	32,000
Shallow clayey	900	75	67,500
Shallow loamy	900	75	67,500
Rock outcrop	0	75	0
			1,475,800***

POTENTIAL FORAGE PRODUCTION AFTER RECLAMATION

Range Site	Yield (lb/ac/yr)*	Acres	Total Yield (lb/yr)**
Shallow loamy	1,300****	1,071	1,392,300***

* Pounds per acre per year.

** Pounds per year.

*** The difference between these total yields represents a 6% loss in productivity after reclamation.

**** The average yield for a shallow loamy range site is 1500 lb/ac/yr of air-dry forage. This reclaimed site may produce a forage comparable to the lower end of a loamy range site due to the altered nature of the replaced overburden. At this time, we cannot project exactly how plant root growth, plant nutrient availability, and water movement would respond to the altered overburden.

TABLE BU3-9

ESTIMATED GROUNDWATER INFLOW TO BUCKSKIN MINE FOR VARIOUS STAGES OF DEVELOPMENT
(Data furnished by applicant.)

Development Stage (Year)	Water Level Altitude (Feet)	Pit Floor Altitude (Feet)	Range In Gradient (Feet/Mile)	Estimated Water Inflow (Gallons/Minute)
1-2	4140-4150	3990	50-100	220
3-4	4150-4160	3975-3980	40-160	400
12	4130-4140	3940	60-70	190
16	4130	3920	70	260

Service would be required under Section 7 of the Endangered Species Act.

Amphibians and Reptiles

Amphibians and reptiles on the site are not highly mobile and would be lost during the initial removal of topsoil.

Frog and turtle species might be able to recolonize the reclaimed stream channel areas. However, the lack of aquatic and riparian vegetation may preclude reestablishment of these species in the reclaimed area. Snake species should be able to recolonize reclaimed areas if sufficient cover and prey are available.

Endangered and/or Threatened Species. No adverse impact to any endangered or threatened species would be anticipated on the proposed Buckskin Mine site, since such species are unknown in the region.

CULTURAL RESOURCES

Prehistoric sites (48 CA 16 and 48 CA 17) lying within the area that would be mined have been tested, and data has been collected from them. Neither site is considered to be of National Register quality by the archeological survey crew (Zeimens et al. 1978).

Prehistoric sites (48 CA 89 and 48 CA 130), which lie in the proposed railroad right-of-way, have been tested. It is determined that both sites are eligible for nomination to the National Register of Historic Places (Zeimens et al. 1978).

Impact to these sites could range from total destruction by mining to partial destruction resulting from construction of the railroad and additional damage by vehicular traffic and vandalism as access is made easier.

Protective stipulations to mitigate potential impact to sites 48 CA 89 and 48 CA 130 have been proposed by the Wyoming State Archeologist and the Bureau of Land Management. (See Chapter 4.) During consultation among the Bureau of Land Management, Wyoming State Historic Preservation Officer, and the Advisory Council on Historic Preservation, it will be determined if these stipulations are adequate or if additional or substitute measures shall be applied.

Overburden stripping at the mine site could destroy buried prehistoric sites of unknown significance.

Population increases in the region could lead to increased destruction of cultural resources due to unauthorized collection and vandalism; however, the actual regional impacts caused by this proposed mine cannot be adequately assessed at this time.

VISUAL RESOURCES

The impacts of the proposed Buckskin Mine on visual resources were determined using the Bureau of Land Management (BLM) contrast rating system. Contrast ratings describe how the proposed project would affect the existing landscape features (land surface, vegetation, and structures) as seen from U.S. Highway 14/16. Contrasts were evaluated for both the life of the mine and after reclamation. (See Table BUA-7, Appendix, for Buckskin project contrast rating, and regional analysis, Appendix B for discussion of visual resource management (VRM) classes.)

During the life of the mine, the contrast ratings for the land surface would exceed the limits of VRM Class IV. Contrasts with the natural landscape would be the open pit, service roads, railroad cuts and fills, power lines, and unshaped overburden. Soil color on roads and spoil piles and the exposed black coal seam would contrast with existing colors.

Contrast ratings for vegetation and structures would be acceptable for Class IV during the life of the mine. Unnatural edges of newly seeded areas and color variation in vegetation would cause only moderate contrasts. The surface facilities for the mine would be in the southeast corner of the permit area, and hence not visible from the highway. Only haul trucks and loaders at the western edge of the mine would be seen.

For the life of the mine, the permit area would be designated Class V, which is an interim classification indicating that rehabilitation is needed to restore an area to its natural character.

After mining is completed and reclamation is successful, contrasts would no longer exceed the limits for Class IV, and the area could be restored to its original class.

Changes in visual resources caused by the Buckskin Mine would not be isolated, but rather an extension of changes caused by other mines nearby. For example, Rawhide and Eagle Butte mines will already be operating 2 and 4 miles south of the Buckskin site respectively. Hence the impact of Buckskin would be considerably less than if it were the only intrusion in an otherwise open plain.

RECREATION RESOURCES

The most important impact of the proposed action on the recreation resources in Campbell County would be more people participating in and demanding recreation opportunities.

As a result of the proposed action, the population of the county is expected to increase by about 630 by 1990. Along with an increased population, the median family income in Campbell County by 1990 is projected to be 36% higher than the state average (Wyoming Recreation Commission 1975). Increases in population and income would mean increased stress on recreation facilities, which are already considered inadequate in Gillette (Table R2-23 in the regional analysis). As a result, more services would have to be planned and managed in order to maintain an acceptable recreation experience. Maintenance costs would increase, as would costs of visitor safety measures and resource protection.

Also, overcrowding of city parks and facilities and increased use of the open plains by hunters, off-road vehi-

cle users, and sightseers would decrease the quality of the recreation experience.

Therefore, although the population increase attributable to Buckskin would be minor (5%) compared to overall population growth in Campbell County by 1990, its impact would be significant.

On the Buckskin site itself, recreation opportunities are negligible now and would be little changed by mining. A minor reduction of huntable wildlife numbers would be the primary impact.

AGRICULTURE

Livestock Production

The construction of roads, fences, the railroad, the mine, and ancillary facilities would disrupt grazing on approximately 80% of the total permit area of 1,760 acres during the life of the mine. A total of 5,120 animal unit months (AUMs) of production would be lost during the life of the mine, with an average annual loss of 256 AUMs. The impact of grazing loss would be distributed between two operators.

The current operators have been bought out by industrial concerns but have leased back the land for grazing purposes. Once the Buckskin and other mining operations commence, the operators expect to continue their operations on adjacent land and on the 20% of the permit area that will still be available.

Once mining is completed, and if reclamation of the area is successfully accomplished, the stocking rate and grazing pattern are expected to return to near premining standards. This is consistent with the Shell Oil land use plan for the area, which assumes that the land would be returned to grazing use. However, forage production studies (Chapter 3, Soils) indicate that the potential forage production after reclamation would be 6% lower than present forage production. This would be a long-term impact. Current annual production is estimated to be 1,475,800 pounds of air-dry forage compared to an estimated 1,392,300 pounds after reclamation.

Surface water hydrology studies (Chapter 3) indicate that overburden settling would cause a pond to be formed varying from 35 to 40 acres due to a 3-foot settlement. This could cause an additional change in potential forage production after reclamation from the figure listed above, which was calculated without the pond. If the 35- to 40-acre lake is formed, total forage production would be reduced to 1,352,300 pounds per year of air-dry forage. This is a reduction of 17% from premining production and would be a long-term loss.

Haul road dust and fugitive coal dust from mining, blasting, transporting, processing, and loading may be deposited on vegetation adjacent to the mine. Dust-covered and damaged vegetation would be less palatable to livestock and wildlife.

The rail spur, access roads, and mine developments would divide grazing areas that are presently used as one continuous pasture. These obstacles to livestock movement could cause trailing (excessive use parallel to the obstacles) and overuse at points where the livestock are moved across to unused range.

The impact on range improvements would be primarily to watering facilities in Rawhide Creek and Spring Draw since mining activities would remove them. For reasons discussed in Chapter 3, Water Resources, it is unlikely that natural point-watering sources in Rawhide Creek and Spring Draw would redevelop in the recreated stream channels.

The alteration of flow of natural springs and the destruction of the riparian zones of Rawhide Creek and Spring Draw would affect the grazing of livestock and wildlife on these watershed areas. The degree of impact would vary according to the location of alternate water sources that may be developed.

Heavy sediment loads combined with flooding (Chapter 3, Water Resources) and possible channel changes could result in loss of crop fields and pasturage and increased silt deposits on fields downstream, resulting in further forage loss.

Farming

Disturbance of scattered areas currently used for cropland production is expected to amount to 121 acres. The 34 acres of barley and wheat production and the 87 acres of hay production are expected to be lost for the life of the mining project. This represents a loss of 960 bushels of barley, 60 bushels of wheat, and 26 tons of hay per year. The total loss would amount to 19,200 bushels of barley, 1,200 bushels of wheat, and 520 tons of hay during the life of the project. Shell Oil's current land use plans do not contemplate the restoration of these farming areas. The Surface Mining Control and Reclamation Act (SMCRA) requires disturbed areas to be restored to a condition which would be capable of supporting the premining use. Any alternative use must be approved by the regulatory authority. Shell Oil may be required to modify their reclamation plan.

MINERAL RESOURCES

The impact of mining to the mineral resources of the site would be the consumption of the coal resource. During the 20-year life of the mine, an estimated 80 million tons of coal would be removed, 1.4 million tons would be left in the lease boundary highwalls, and an additional 2.6 million tons would be lost due to lack of recovery by present mining methods. An estimated 2 million tons would be removed by 1980, 22 million tons by 1985, and 42 million tons by 1990.

An unquantifiable amount of scoria, sand, and gravel would be used for mine facilities and possibly urban construction.

TRANSPORTATION NETWORKS

Railroads

A 6-mile private railroad spur to the Buckskin Mine site would be constructed from the terminus of the Burlington Northern-(BN)-owned portion of the 11-mile line originating at Donkey Creek, east of Gillette. One 100-car train per day would be required in 1980 to haul coal produced at Buckskin. Two trains per day would be required in 1985 and 1990. (Each car would carry 100 tons of coal.)

The proposed railroad spur would pass under State Highway 59 and intersect some tertiary roads where it could cause crossing hazards.

With increased rail movement from the mining site, noise levels would increase above existing levels.

Highways

Access to the proposed Buckskin Mine would be provided by construction of a 2-mile improved road from U.S. Highway 14/16 to the southeast corner of the lease. Commuter traffic on U.S. Highway 14/16 between the Buckskin Mine and Gillette would increase traffic flow and may increase the rate of highway deterioration. Based upon peak mine-related population increases (843) and a current vehicle registration rate of 945 per 1,000 population, the number of registered vehicles in Campbell, Converse, and Crook counties should increase by 794 by 1990 because of the Buckskin Mine (personal communication, Dee Herber, Wyoming State Department of Revenue 1977). No existing roads would be relocated during mining operations.

Other

The Gillette-Campbell County Airport could expect increased air operations (total departures and arrivals) because of traffic associated with the proposed Buckskin Mine. The mine-related peak population increase expected in Campbell County would be 730. This would mean an increase in both individual and corporate air operations and further strain the already inadequate passenger and freight capabilities of the airport. It is estimated that annual operations would increase by approximately 3,796 due to the approval of the proposed action. This is based on a 1976 total air operations to county population ratio of 5.2.

Power for the Buckskin Mine would be generated at the 330-Mw Wyodak Power Plant. There would be no disturbances to existing transmission lines from the mining operations, but 6 miles of new 69-kv power line would be constructed along Buckskin's railroad spur from the Rawhide Mines power line.

Given the capabilities of the present telephone system and the small increase in population due to Buckskin, the impact would be negligible.

SOCIOECONOMIC CONDITIONS

Introduction

The Buckskin Mine is only part of the development of coal (about 2% of that produced by 1990) and other energy resources possible in the Eastern Powder River Basin. It is important to remember that by their very nature, socioeconomic impacts may be of a regional scope, and not limited to a geographically defined site-specific area. Each individual energy development's socioeconomic impacts, when viewed alone, may be negligible, but its effect on cumulative impacts can be very significant. Thus, it is crucial for the reader to view this or any other site-specific analysis not only by itself, but also in terms of cumulative regional impacts.

Sociocultural Impacts

Population increases associated with the Buckskin Mine would contribute, particularly in Gillette, to regional social problems and changes in life-style already occurring. See Chapters 2 and 4 of the regional analysis for a discussion of these sociocultural changes.

Economic Impacts

Population

Table BU3-16 compares population projections with and without the Buckskin Mine. Measurable population impacts due to Buckskin would be expected only in Gillette, Douglas, and Moorcroft. A handful of workers and their families might elect to live in the unincorporated settlement of Wright in Campbell County.

These projections reflect employment at Buckskin in the years 1980, 1985, and 1990, the years selected for analysis. Fluctuations in employment figures for other years, particularly regarding the construction work force, should not substantially alter the nature or magnitude of the impacts discussed below.

Virtually all of the Buckskin-related population growth (92% as of 1980, 83% as of 1985, and 87% as of 1990) is projected to reside in Campbell County, primarily in Gillette. Much of the population increase in Douglas would be attributable to increased railroad employment generated by coal shipments from Buckskin. In addition, some Buckskin workers and their families would be expected to reside in Moorcroft.

TABLE BU3-16

PROJECTED POPULATION IMPACTS OF BUCKSKIN MINE

County / City	1980			1985			1990		
	Population Without Buckskin	Population With Buckskin	Increment Attributable to Buckskin	Population Without Buckskin	Population With Buckskin	Increment Attributable to Buckskin	Population Without Buckskin	Population With Buckskin	Increment Attributable to Buckskin
Campbell	28,125	28,222	97	33,828	34,261	383	38,853	39,583	730
Gillette	22,258	22,353	95	28,008	28,383	375	32,983	33,705	722
Other Areas*	5,867	5,869	2	5,870	5,878	8	5,870	5,878	8
Converse	13,019	13,021	2	21,065	21,114	49	19,726	19,811	85
Douglas	8,368	8,370	2	15,006	15,055	49	13,595	13,680	85
Glenrock	3,137	3,137	0	4,542	4,542	0	4,614	4,614	0
Other Areas	1,514	1,514	0	1,517	1,517	0	1,517	1,517	0
Crook	5,434	5,438	4	6,292	6,319	27	6,809	6,837	28
Moorcroft	1,482	1,486	4	2,334	2,361	27	2,851	2,879	28
Other Areas	3,952	3,952	0	3,958	3,958	0	3,958	3,958	0
Total 3 Counties	46,578	46,681	103	61,235	61,694	459	65,388	66,231	843

Source: University of Wyoming 1978.

* Includes unincorporated settlement of Wright.

IMPACTS OF THE PROPOSAL

Employment

Projected employment impacts of Buckskin Mine would be felt in three counties: Campbell, Converse, and Crook. The bulk of the employment would consist of workers at Buckskin, although by 1990 indirect and induced employment in the railroad, construction, services, and government sectors would make up a large share of the total.

Permanent employment at Buckskin would reach 133 by 1990, of whom 125 (94%) would be expected to reside in Campbell County, with the remainder commuting from neighboring Crook County. The construction work force at the mine, which would peak at 262 during the third quarter of the first full year of construction and average 197 for the year, would probably show approximately the same percentage distribution between Campbell and Crook counties as shown above. Shipments of coal from Buckskin would lead to a 25-person increase in railroad employment by 1990. About two-thirds of this additional rail employment would be expected in Converse County, and the remainder in Campbell County. In addition to employment at the mine and on the railroad, the creation of 134 additional jobs in the construction, services, and government sectors would be expected; 112 would be in Campbell County.

Compared with regional employment projections, employment associated with Buckskin would represent a 2% increase in Campbell County, and less than a 1% increment in Converse and Crook counties. After 1980, many of the additional jobs created would probably be filled by immigrants from outside the region, due to the already extremely low local unemployment rates.

Income

Beginning in 1980, the Buckskin Mine would cause a relatively small but measurable increase in local earnings in Campbell, Converse, and Crook counties. Table BU3-17 summarizes the income impacts of Buckskin by county.

In 1980, the mine is expected to generate $7.1 million in additional earnings (measured in 1975 dollars) in the three counties affected, a 1% increase over earning levels foreseen without Buckskin. Virtually all of this increase would be accounted for by direct operating and construction manpower requirements at the Buckskin Mine, and it would be primarily restricted to Campbell County.

By 1985, earnings attributable to the mine (including railroad earnings) would reach $9.1 million (1975 dollars), approximately 1% above the earnings forecast without Buckskin. Almost nine-tenths of this incremental income would be concentrated in Campbell County, with the remainder divided between Converse and Crook counties.

In 1990, direct, indirect, and induced earnings attributable to Buckskin would be $14.2 million (1975 dollars), including railroad earnings. This would represent a 1.2% increase above the 1990 earnings forecast without the mine. Only $5.6 million, or 39% of the total, would be direct mine earnings; the remainder would consist of indirect and induced earnings in other sectors. More than 90% of all mine-related earnings would accrue to Campbell County.

Public Sector Impacts

Local Government

Buckskin-related population increases would increase the revenues at the disposal of local governments, while simultaneously increasing their operating and capital outlay requirements.

Principally due to the large property tax base at their disposal, local county governments and school districts should be able to meet the additional service and educational requirements of the Buckskin-related population. For municipal governments, the outlook would be mixed. Gillette's projected operating revenues appear sufficient to meet the city's operating requirements through 1990, both with and without Buckskin. However, Douglas would face a maximum operating shortfall of $1 million annually by 1985 without Buckskin. Moorcroft could be short by as much as $25,000 annually by 1990. Buckskin would have a minor additional adverse impact on Douglas' and Moorcroft's operating budgets.

Municipal governments vary in their ability to meet the capital costs of additional facilities, as discussed in Chapter 4 of the regional analysis. Population increases attributable to Buckskin are not expected to necessitate any additional capital expenditures.

Local Services

Some local services (e.g., police and fire protection, water supplies, and sewage treatment) in Campbell, Converse, and Crook counties are already inadequate. The additional population growth attributable to the Buckskin Mine would, in some cases, cause additional marginal adverse impacts on these services.

Nearly all of the Buckskin-related population would be expected to reside in the incorporated areas of Gillette, Douglas, and Moorcroft. The marginal impact of Buckskin on county law enforcement and fire protection services would therefore be small.

Gillette is the only one of the three municipalities under consideration which would experience discernible service impacts as a result of the Buckskin Mine. However, these impacts would be quite marginal when compared with the impacts of the total population forecast. For example, without any new coal development, 29 additional police officers and ten additional police cars would be required by 1990; the incremental population attributable to Buckskin would create a need for a thirteenth new officer by 1990, but no new police cars.

To ensure adequate fire protection for the projected population, Gillette would need additional pumper trucks with a total capacity of 1,500 gallons per minute plus six more full-time firemen (or eighteen volunteers) by 1990. These requirements would not be affected by Buckskin.

TABLE BU3-17

INCREMENTAL EARNINGS ASSOCIATED WITH THE BUCKSKIN MINE, 1980-1990
(Millions of 1975 Dollars)

	Campbell			Converse			Crook			Three-County Total		
	1980	1985	1990	1980	1985	1990	1980	1985	1990	1980	1985	1990
Agriculture	0	0	0	0	0	0	0	0	0	0	0	0
Minerals Extraction	2.2	4.3	5.5	0	0	0	0.1	0.1	0.1	2.3	4.4	5.6
Construction	4.5	0	1.2	0	0	0	0.3	0	0	4.8	0	1.2
Manufacturing	0	0	0	0	0	0	0	0	0	0	0	0
Railroads	0	0.1	0.1	0	0.2	0.2	0	0	0	0	0.3	0.3
Business/Consumer Services	0	2.8	4.0	0	0.2	0.2	0	0.2	0.6	0	3.0	4.8
Government/Education	0	1.0	2.0	0	0.1	0.1	0	0.1	0.2	0	1.1	2.3
Military	0	0	0	0	0	0	0	0	0	0	0	0
Totals	6.7	8.2	12.8	0	0.5	0.5	0.4	0.4	0.9	7.1	9.1	14.2

Source: University of Wyoming 1978.

Note: Excludes corporate income.

Likewise, Gillette's water and sewage treatment needs, although substantial in themselves, would not be significantly affected by Buckskin. By 1990, the city would need to increase its combined water supply and treatment capacity to 15.2 million gallons per day. Its current sewage treatment capacity (1.4 mgd) would have to be expanded to some 5.7 mgd by 1990 to meet the demands of the projected population.

Even without new coal development, Douglas would be faced with the problem of planning services for over 15,000 people by 1985 which would not result in long-term overcapacity when the population declines to under 13,700 after 1985. Further population increases due to the Buckskin Mine would not necessitate any increments to peak service levels. Conversely, the additional Buckskin-related population would not be sufficient to have any significant cushioning effect when the population declines after 1985.

The small increments in Moorcroft's population attributable to Buckskin would not appear to warrant any significant changes in the level of police or fire coverage, or any expansion of the town's water supply or sewage treatment facilities beyond already projected needs.

Health Care

Table BU3-18 contains projections of the number of physicians, registered nurses, and dentists necessary to provide adequate health care to the populations of Campbell, Converse, and Crook counties. The impact of Buckskin-related population growth on these requirements would be insignificant. Despite the recent success of the Campbell County Hospital Board in recruiting five more doctors, the shortage of doctors would probably remain a critical problem in the three counties.

The shortage of doctors is one reason why the underutilization of hospital facilities in the three counties is expected to continue. Another reason is the relatively small size of the hospitals, which precludes offering some types of sophisticated treatment. (Hospital bed occupancy rates in Campbell, Converse, and Crook counties are 51%, 48%, and 16% respectively, compared with the nationwide average of 77%.) Many local residents travel to Casper, or even outside the region, for hospital care. For this reason, although Campbell County is currently building a new 55-bed hospital, hospital needs must be assessed on a regionwide basis.

Based on the current average regional hospital occupancy rate of 46%, the region would have an adequate supply of hospital beds through 1980. However, even with planned local hospital expansions, the region as a whole would experience a shortfall of 183 beds by 1990 (186 including Buckskin).

Education

Three school districts would experience Buckskin-related impacts on student enrollments: the Campbell County School District; Converse County School District No. 1; and the Crook County School District. The incremental impacts of Buckskin Mine on these three school districts are shown in Table BU3-19. These impacts are quite minor when viewed in the context of overall projected enrollment increases: an increment of 1.6% in Campbell County, 0.5% in Converse County No. 1, and 0.5% in Crook County.

These enrollment increases would not have any major effect on the capital facility requirements of the three school districts (see Chapter 4 of the regional analysis).

Enrollment due to Buckskin would necessitate Campbell County's hiring up to 7 additional teachers by 1990. In Douglas and Crook County, the impact of Buckskin-related enrollment on long-term additional teacher requirements would be negligible.

Private Sector Impacts

Housing

Table BU3-20 shows projected housing demand with and without the Buckskin Mine in Gillette, Douglas, and Moorcroft. The incremental growth in housing demand attributable to Buckskin would vary from 0% to 0.4% annually, depending on the locality and the type of housing.

Based on comparisons with historical rates of growth in the local single-family housing stock, local builders appear capable of meeting the demand for single-family homes through 1990. However, Table BU3-20 measures only effective demand, i.e., households desiring *and* able to afford the high cost of single-family housing. In Gillette, the number of households desiring, but unable to afford, single-family housing is estimated at approximately 750 by 1990 (775 including Buckskin). In Douglas it is anticipated that 350 households (360 including Buckskin) would be unable to afford the single-family homes they desire by 1985. (If Douglas' population declines after 1985 as projected, it may cause a significant drop in housing costs, increasing the availability of single-family homes.) In Moorcroft, approximately 160 households by 1990 (no significant incremental impacts due to Buckskin) would be prevented from buying the single-family homes they desire by high housing costs.

Even at inflated production costs, the majority of the new mining employees would be able to qualify for single-family homes. Table BU3-21 summarizes the anticipated wage distribution of the workers at the proposed Buckskin Mine. More than half would have household incomes of over $20,000 per year, even if there are no second wage earners in the households. Most of the new employees in the service sector jobs indirectly resulting from the mine would be able to afford single-family units only if there are two or more full-time wage earners in the household and/or the cost of new housing is reduced.

The population growth directly and indirectly resulting from Buckskin would also increase demand for, and thus the likelihood of shortages in rental apartments, transient accommodations, and mobile home spaces.

TABLE BU3-18

PROJECTED HEALTH MANPOWER REQUIREMENTS

	1977 Physicians	Physicians Recommended Level*			1977 Registered Nurses	Registered Nurses Recommended Level**			1977 Dentists	Dentists Recommended Level***		
		1980	1985	1990		1980	1985	1990		1980	1985	1990
Campbell	9	28	34	39	53	99	120	134	4	18	21	25
Converse	6	13	21	20	29	46	74	70	2	8	13	12
Crook	2	5	6	7	11	19	22	24	1	3	4	4

Source: Wyoming Department of Health and Social Services 1977; personal communication, Larry Bertilson, State Health Planning Manager, 1978.

* Based on recommended standard of 1,000 persons per physician.
** Based on recommended standard of 285 persons per registered nurse.
*** Based on recommended standard of 1,600 persons per dentist.

TABLE BU3-19

SCHOOL DISTRICT ENROLLMENT PROJECTIONS

Enrollment Projections Without Buckskin

	1980				1985				1990			
	Elem.	J. H.	H. S.	Total	Elem.	J. H.	H. S.	Total	Elem.	J. H.	H. S.	Total
Campbell Gillette	2,813	1,125	844	6,782	3,388	1,355	1,016	5,759	3,885	1,554	1,165	6,604
Converse Douglas	1,312	469	375	2,156	2,243	801	640	3,684	2,046	730	584	3,360
Crook Sundance	714	359	334	1,407	826	415	388	1,629	894	450	419	1,763

Enrollment Projections With Buckskin

	1980				1985				1990			
	Elem.	J. H.	H. S.	Total	Elem.	J. H.	H. S.	Total	Elem.	J. H.	H. S.	Total
Campbell Gillette	2,822	1,129	847	4,748	3,476	1,370	1,028	5,824	3,948	1,599	1,184	6,711
Converse Douglas	1,312	469	375	2,156	2,248	803	642	3,193	2,055	784	587	3,876
Crook Sundance	713	359	335	1,408	829	417	389	1,637	897	451	421	1,771

Source: University of Wyoming 1978.

TABLE BU3-20

PROJECTED HOUSING DEMAND, 1977-1990

Community Housing Type	1977 Housing Stock	Average Annual Growth Rate of Housing Stock, 1970-77	Additional Demand for Housing Units, 1977-1990: Without Buckskin: No. of Units	Without Buckskin: Average Annual Growth in Housing Stock	With Buckskin: No. of Units	With Buckskin: Average Annual Growth in Housing Stock
Gillette*						
Single Family	1,623	5.2%	1,857	6.0%	2,007	6.4%
Multi-Unit	680	6.3%	486	4.2%	513	4.4%
Mobile	1,542	13.3%	1,492	5.3%	1,573	5.6%
TOTAL ALL TYPES	3,845	8.1%	3,835	5.5%	4,093	5.7%
Douglas						
Single Family	1,232	6.5%	721	3.6%	728	3.6%
Multi-Unit	207	0.7%	350	7.9%	353	8.0%
Mobile	349	24.8%	1,206	12.2%	1,228	12.3%
TOTAL ALL TYPES	1,788	8.2%	2,277	6.5%	2,309	6.6%
Moorcroft						
Single Family	147	NA	285	8.6%	296	8.9%
Multi-Unit	0	NA	63	---	65	---
Mobile	150	NA	230	7.4%	233	7.5%
TOTAL ALL TYPES	297	NA	578	8.7%	594	8.8%

Note: Two major factors were taken into account in compiling Table BU3-20: workers' personal preferences for different types of housing and their ability to pay for the type of housing desired. See notes for Table R4-24 in the regional analysis for an explanation of these factors.

* 1977 data for Gillette do not include housing located outside city limits since compatable data for 1970 were not obtainable. Consequently, average growth rate in Gillette's housing stock 1970-77 is probably understated.

NA = not available.

TABLE BU3-21

ANTICIPATED INCOME DISTRIBUTION FOR EMPLOYEES AT THE PROPOSED MINE

Annual Income	Percent of Total Employees
$30,000 and above	2.5
$25,000-$30,000	12.5
$20,000-$25,000	50
$15,000-$20,000	25
$15,000 and below	10
Total	100

Source: Shell Oil Company 1977.

TABLE BU3-22

APPLICABILITY OF SURFACE MINING CONTROL AND RECLAMATION ACT (SMCRA) PROVISIONS TO IMPACTS OF THE PROPOSED ACTION

Reference Number	Description of Impact of Proposed Action	SMCRA Performance Standards Bear on Impact
Air Quality		
AQ-1	Generation of fugitive dust emissions would cause an increase in total suspended particulates (TSP)	No
AQ-2	Visibility would be reduced by increased TSP	No
AQ-3	Vehicle emissions would be generated	No
Topography		
TO-1	Smooth depression would result after mining	No
TO-2	Landforms would be altered during mining	No
TO-3	Some railroad and road cuts may remain after mining	No
Geology		
GE-1	Part of the geologic record would be lost	No
GE-2	Ground stability would be decreased	No
GE-3	Rock hunting would increase	No
Paleontology		
PA-1	Potential fossil-bearing strata would be lost	No
PA-2	Unauthorized fossil collecting would increase	No

TABLE BU3-22
(cont'd)
APPLICABILITY OF SURFACE MINING CONTROL AND RECLAMATION ACT (SMCRA) PROVISIONS
TO IMPACTS OF THE PROPOSED ACTION

Reference Number	Description of Impact of Proposed Action	SMCRA Performance Standards Bear on Impact
Soils		
SO-1	Soil productivity would be reduced after reclamation	Yes (30 CFR 715.13)
SO-2	Soil productivity would be lost for new urban areas	No
SO-3	Soil productivity would be lost while areas are being mined	No
SO-4	Topsoil would be lost to erosion	Yes (30 CFR 715.16 and 715.20)
SO-5	Topsoil could be contaminated by toxic materials	Yes (30 CFR 715.16)
Groundwater		
GW-1	Water quality would be lowered in spoils after reclamation	Yes (30 CFR 715.17)
GW-2	Water levels would be lowered in adjacent aquifers during mining	Yes (30 CFR 715.17)
GW-3	A valley which has been designated as alluvial could be disturbed	Yes (30 CFR 715.17)
GW-4	Water levels would be nearer the surface in spoils	Yes (30 CFR 715.17 and 715.14)
GS-5	Infiltration and recharge would be altered in the spoil after reclamation	Yes (30 CFR 715.17)
GS-6	Coal and overburden aquifers would be destroyed by mining	No
GS-7	Consumptive use of groundwater could affect other users	Yes (30 CFR 715.17)

TABLE BU3-22
(cont'd)
APPLICABILITY OF SURFACE MINING CONTROL AND RECLAMATION ACT (SMCRA) PROVISIONS
TO IMPACTS OF THE PROPOSED ACTION

Reference Number	Description of Impact of Proposed Action	SMCRA Performance Standards Bear on Impact
Surface Water		
SW-1	Surface water system would be destroyed by mining, water would be diverted around the mine	Yes (30 CFR 715.17)
SW-2	After reclamation, surface water system would be altered from existing characteristics	Yes (30 CFR 715.13, 715.14, 715.17)
SW-3	Shallow ponding could result after reclamation	Unknown
SW-4	Peripheral gullying could result after reclamation	Yes (30 CFR 715.13, 715.14, 715.17)
SW-5	During flooding, sedimentation would increase due to high stream velocities	No
SW-6	Breaching of bypass channel and impoundment would release low quality water downstream	Yes (30 CFR 715.17)
SW-7	Leachate and surface runoff could enter the surface water system during mining	Yes (30 CFR 715.17)
SW-8	Increased surface water use by new population would occur	No
SW-9	Water quality could be lowered by sewage effluents	No
Vegetation		
VG-1	Vegetative productivity would be reduced after reclamation	Yes (30 CFR 715.13 and 715.20)
VG-2	Vegetative productivity would be lost for new urban areas	No
VG-3	Vegetative productivity would be lost while areas are being mined	No

TABLE BU3-22
(cont'd)
APPLICABILITY OF SURFACE MINING CONTROL AND RECLAMATION ACT (SMCRA) PROVISIONS
TO IMPACTS OF THE PROPOSED ACTION

Reference Number	Description of Impact of Proposed Action	SMCRA Performance Standards Bear on Impact
Vegetation (cont'd)		
VG-4	Species variety would be reduced	Yes (30 CFR 715.20)
VG-5	Vegetative productivity could be reduced by dust deposition during mining	No
VG-6	Fire hazard would be increased during mining	No
VG-7	Aquatic vegetation would be adversely affected	Yes (30 CFR 715.13, 715.14, 715.17)
VG-8	Vegetative productivity could be reduced by topsoil erosion	Yes (30 CFR 715.16 and 715.20)
Wildlife		
WL-1	Wildlife habitat quality would be reduced after reclamation (affecting populations and carrying capacity)	Yes (30 CFR 715.13)
WL-2	Wildlife habitat would be lost during mining	No
WL-3	Carrying capacity would be lost during mining	No
WL-4	Wildlife populations would be reduced	No
Cultural Resources		
CR-1	Known cultural sites could be damaged by mining activities	No
CR-2	Unknown sites could be uncovered and/or damaged by mining activities	No
CR-3	Cultural artifacts could be damaged or lost by increased unauthorized collecting	No

TABLE BU3-22
(cont'd)
APPLICABILITY OF SURFACE MINING CONTROL AND RECLAMATION ACT (SMCRA) PROVISIONS
TO IMPACTS OF THE PROPOSED ACTION

Reference Number	Description of Impact of Proposed Action	SMCRA Performance Standards Bear on Impact
Visual Resources		
VR-1	Visual quality on the mine site would be reduced from Class IV to Class V	No
VR-2	Visual quality in new urban areas would be reduced from Classes II, III, or IV to Class V	No
Recreation Resources		
RR-1	Use of recreation facilities would be intensified	No
RR-2	"Primitive" recreation quality would be reduced	No
RR-3	Conflicts between landowners and recreationists would increase	No
RR-4	Numbers of huntable wildlife would be reduced	No
RR-5	Mining and urban expansion would reduce the land use base	No
RR-6	Sightseeing of natural landscapes would be reduced	No
Agriculture		
AG-1	AUMs (carrying capacity) would be reduced after reclamation	Yes (30 CFR 715.13)
AG-2	AUMs would be lost while areas are being mined	No
AG-3	AUMs would be lost for new urban areas	No
AG-4	Forage productivity could be reduced by dust fallout	No
AG-5	Animal harassment and unintentional openings of enclosures would increase	No

TABLE BU3-22
(cont'd)
APPLICABILITY OF SURFACE MINING CONTROL AND RECLAMATION ACT (SMCRA) PROVISIONS
TO IMPACTS OF THE PROPOSED ACTION

Reference Number	Description of Impact of Proposed Action	SMCRA Performance Standards Bear on Impact
Agriculture (cont'd)		
AG-6	New rail and road access could split pastures and interrupt agricultural operations	No
AG-7	Surface water system alteration would affect agricultural operations	Yes (30 CFR 715.13, 715.19)
AG-8	Increased sediment release during floods would affect productivities	Yes (30 CFR 715.17)
AG-9	121 acres of cropland would be destroyed and not reestablished by reclamation	Yes (30 CFR 715.13)
Mineral Resources		
MR-1	Coal would be converted to electrical energy	No
MR-2	Some coal would not be recovered	No
MR-3	Sand, gravel, and scoria would be consumed in construction activities	No
Transportation Networks		
TR-1	Rail traffic would increase	No
TR-2	Street and highway traffic would increase	No
TR-3	Traffic and use of the Gillette airport would increase	No
Socioeconomic Conditions		
SE-1	City of Gillette would experience increased fiscal stress	No
SE-2	Housing requirements and needs would intensify	No
SE-3	Quality of life and character of Gillette and Campbell County would be changed	No
SE-4	Employment and wages would increase	No

CHAPTER 4

MITIGATING MEASURES

INTRODUCTION

The discussion and analysis of effectiveness for requirements which would reduce impacts resulting from mining and reclamation on the Buckskin site are presented in this chapter. There are two categories of requirement which would bear on this project.

The recent enactment of the Surface Mining Control and Reclamation Act of 1977 (SMCRA) and promulgation of regulations (Title 30 CFR Part 700) to implement the act require the mine permittee (Shell Oil Company) to revise and resubmit the mining and reclamation plan. The revisions are necessary to bring the plan into compliance with SMCRA. The first category of requirement (SMCRA performance standards) represents an effort to anticipate the performance standards of SMCRA which require revisions in the plan. To the extent possible, the performance standards are analyzed for their general effectiveness in relieving specific impacts on the Buckskin site. Regulations cited were published in final form in December 1977.

The second category of requirement (committed measures) includes all those measures which are real, committed, and will be enforced. An analysis of the effectiveness of each committed mitigating measure is also included in this discussion.

Table BU4-1 at the end of this chapter summarizes the effectiveness of both categories of requirement, and the impact remaining after mitigation (residual impact).

SMCRA PERFORMANCE STANDARDS

Postmining Use of Land (30 CFR 715.13)

All disturbed areas shall be restored in a timely manner to conditions that are capable of supporting the uses which they were capable of supporting before any mining or to higher or better uses if approved by the regulatory authority.

It appears from the calculations presented in Tables BU3-6 through BU3-8 that long-term soil productivity (and hence vegetative productivity) would eventually stabilize at 94% of premining levels on the Buckskin site, unless some modification of the reclamation plan raises the productivity. The methodology used to calculate this productivity is explained in Chapter 2, Soils, of the regional analysis. Although the methodology has not been verified on mined lands, it has been used successfully to predict productivity on lands reclaimed from other types of disturbance.

Presently, 121 acres of the Buckskin site are, or have been in the past, used as cropland. Under the present plan, these would be reclaimed as rangeland. An evaluation will be required to determine whether this sort of conversion would be allowed as an approved postmining land use.

Backfilling and Grading—Thin Overburden (30 CFR 715.14(g))

In surface coal mining operations carried out continuously in the same limited pit area for more than 1 year where the volume of all available spoil and suitable waste materials is demonstrated to be insufficient to achieve approximate original contour, surface coal mining operations shall be conducted to meet, at a minimum, the following standards:

(1) Transport, backfill, and grade, using all available spoil and suitable waste materials from the entire mine area, to attain the lowest practicable stable grade, which may not exceed the angle of repose, and to provide adequate drainage and long-term stability of the regraded area.

(2) Eliminate highwalls by grading or backfilling to stable slopes not exceeding 50% or such lesser slopes as the regulatory authority may specify to reduce erosion, maintain the hydrologic balance, or allow the approved postmining land use.

(3) Transport, backfill, grade, and revegetate to achieve an ecologically sound land use compatible with the prevailing land use in unmined areas surrounding the permit area.

(4) Transport, backfill, and grade to ensure that the impoundments are constructed only where it has been demonstrated to the regulatory authority's satisfaction that all requirements of κ 715.17 have been met and that the impoundments have been approved by the regulatory authority as meeting the requirements of this part and all other applicable federal and state regulations.

On the Buckskin site, overall lowering of the mined area and differential settlement could cause shallow ponding, peripheral gullying, changed drainage patterns, and other attendant impacts.

The shallow ponding would result from a general lowering of the reclaimed surface toward the water table level. Shallow ponding would affect the surface hydrologic system, and thereby affect the postmining land use

for agriculture and wildlife. These impacts would be minimized by reconstructing the natural slopes as closely as possible; replacing the original contour and configuration of the natural drainage pattern as closely as possible; and compacting the backfill of the replaced valley floor which carries the new main stream channel. Sufficient extra overburden should be placed on top of the lowest areas of replaced overburden so that the stabilized contours after settlement are near those shown on the post-mining contour map.

Topsoil Handling (30 CFR 715.16)

To prevent topsoil from being contaminated by spoil or waste materials, the permittee shall remove the topsoil as a separate operation from areas to be disturbed. Topsoil shall be immediately redistributed on areas graded to the approved postmining configuration. The topsoil shall be segregated, stockpiled, and protected from wind and water erosion and from contaminants which lessen its capability to support vegetation if sufficient graded areas are not immediately available for its redistribution.

On the Buckskin site, a reduction in quality would occur in stockpiled topsoil due to unavoidable erosion and loss of native seeds, microorganisms, organic matter, nutrients, and vegetative propagules. Accidental spillage of oil, gas, or other toxic materials would contaminate small amounts of soil, but such spillage would be localized and of little relative significance.

As long as there are only 25 inches of "topsoil"material present on the site as indicated in Table BU3-6, any soil amendments such as fertilizer or organic matter can only result in a temporary increase in productivity. If a greater depth of "topsoil"material were replaced, such as 30 inches, along with the appropiate soil amendments, the long-term productivity of the site should equal or exceed the premining productivity.

If a major flood occurs, such as a 25-, 50-, or 100-year flood, when topsoil material is exposed, accelerated unquantifiable erosion would occur which would result in large amounts of soil loss. (See also Committed Measure (F) below.)

Realistically, soil protective measures are not likely to be more than 90%-95% effective in protecting topsoil.

Protection of the Hydrological System (30 CFR 715.17)

The permittee shall plan and conduct coal mining and reclamation operations to minimize disturbance to the prevailing hydrologic balance in order to prevent long-term adverse changes in the hydrologic balance that could result from surface coal mining and reclamation operations, both on and offsite. Changes in water quality and quantity, in the depth to groundwater, and in the location of surface water drainage channels shall be minimized such that the postmining land use of the disturbed land is not adversely affected and applicable federal and state statutes and regulations are not violated. The permittee shall conduct operations so as to minimize water pollution and shall, where necessary, use treatment methods to control water pollution. The permittee shall emphasize surface coal mining and reclamation practices that will prevent or minimize water pollution and changes in flows in preference to the use of water treatment facilities. Practices to control and minimize pollution include, but are not limited to, stabilizing disturbed areas through grading, diverting runoff, achieving quick-growing stands of temporary vegetation, lining drainage channels with rock or vegetation, mulching, sealing acid-forming and toxic-forming materials, and selectively placing waste materials in backfill areas. If pollution can be controlled only by treatment, the permittee shall operate and maintain the necessary water-treatment facilities for as long as treatment is required.

Specifically, 30 CFR 715.17 provides for protection of the hydrologic system by establishing requirements for:

—water quality standards and effluent limitations,

—surface water monitoring,

—diversion and conveyance of overland flow away from disturbed areas,

—stream channel diversions,

—sediment control measures,

—discharge structures,

—handling of acid and toxic materials,

—minimizing and monitoring effects on ground water recharge, flow, and quality,

—replacement of water supplies affected by mining operations,

—preservation of essential hydrologic functions of alluvial valley floors throughout the mining and reclamation process,

—permanent impoundments, and

—hydrologic impacts of roads and other transport facilities.

For alluvial valley floors, such as that identified on the Buckskin Mine site, the regulations require that surface coal mining operations conducted in or adjacent to alluvial valley floors shall be planned and conducted so as to preserve the essential hydrologic functions of these alluvial valley floors throughout the mining and reclamation process. These functions shall be preserved by maintaining or reestablishing those hydrologic and biologic characteristics of the alluvial valley floor that are necessary to support the functions.

Also, surface coal mining operations located west of the 100th meridian west longitude shall not interrupt, discontinue, or preclude farming on alluvial valley floors and shall not materially damage the quantity or quality of surface or groundwater that supplies these valley floors unless the premining land use has been undeveloped rangeland which is not significant to farming on the alluvial valley floors or unless the area of affected alluvial valley floor is small and provides negligible support for the production from one or more farms.

Also, before surface mining and reclamation operations may be issued a new permit, the permittee shall submit, for regulatory authority approval, detailed surveys and baseline data from which the degree of material damage to the quantity and quality of surface and groundwater

that supply the alluvial valley floors may be assessed. The surveys and data shall include (a) a map, at a scale determined by the regulatory authority, showing the location and configuration of the alluvial valley floor; (b) baseline data covering a full water year; (c) plans showing how the operation will avoid, during mining and reclamation, interruption, discontinuance, or preclusion of farming on the alluvial valley floors and will not materially damage the quantity or quality of water in surface and groundwater systems that supply such valley floors; (d) historic land use data for the proposed permit area and for farms to be affected; and (e) such other data as the regulatory authority may require.

On the Buckskin site, degraded land use and water quality downstream from the mine site from erosion and leachate from removed overburden may be totally mitigated through planting vegetation on soil storage piles and use of temporary diversions to impoundments. Velocities in bypasses which would be higher than those normally traversing the area in the natural stream may be mitigated by vegetating and roughening the channel. (This, however, decreases the efficiency of the bypass and defeats its purpose of diverting flood flows around the mine in the most expeditious manner.) Any effect higher water velocities might have farther downstream would probably be dissipated in a short distance after reaching the natural channel. Degraded water and land use downstream due to slugs of contaminants and sediment flushed out as a result of breaching of bypasses and impoundments may be completely eliminated through adequate hydraulic design and retaining portions of the stream valley with its natural channel.

Less grazing use due to lost point-watering sources (if the postmining water table is lowered through elimination of the original groundwater system) would be completely mitigated through replacement of as much water surface as had previously been in existence. This might be accomplished through the construction of stock ponds and wells tapping water below the spoil.

Possible water contamination through increased water use and wastes could be completely mitigated through proper sewage treatment facilities.

Characteristics of groundwater recharge, flow, and quality would be minimally changed on the Buckskin site. However, it is still anticipated that recharge and flow may be altered to some degree, and that water quality would be decreased, although data are not available to measure the degree of change.

Revegetation (30 CFR 715.20)

The permittee shall establish on all land that has been disturbed, a diverse, effective, and permanent vegetative cover of species native to the area of disturbed land or species that will support the planned postmining uses of the land.

Revegetation shall be carried out in a manner that encourages a prompt regrowth of vegetative cover and recovery of productivity levels compatible with approved land uses. The vegetative cover shall be capable of stabilizing the soil surface with respect to erosion. All disturbed lands, except water areas and surface areas of roads that are approved as a part of the postmining land use, shall be seeded or planted to achieve a vegetative cover of the same seasonal variety native to the area of disturbed land. Vegetative cover will be considered of the same seasonal variety when it consists of a mixture of species of equal or superior utility for the intended land use when compared with the utility of naturally occurring vegetation during each season of the year.

Where hayland, pasture, or range is to be the postmining land use, the species of grasses, legumes, browse, trees, or forbs for seeding or planting and their pattern of distribution shall be selected by the permittee to provide a diverse, effective, and permanent vegetative cover with the seasonal variety, succession, distribution, and regenerative capabilities of species native to the area. Livestock grazing will not be allowed on reclaimed land until the seedlings are established and can sustain managed grazing.

Where wildlife habitat is to be included in the postmining land use, the permittee shall consult with appropriate state and federal wildlife and land management agencies and shall select those species that will fulfill the needs of wildlife, including food, water, cover, and space. Plant groupings and water resources shall be spaced and distributed to fulfill the requirements of wildlife.

The ground cover of living plants on the revegetated area shall be equal to the ground cover of living plants in an approved reference area for a minimum of two growing seasons. The ground cover shall not be considered equal if it is less than 90% of the ground cover of the reference area for any significant portion of the mined area.

Species diversity, distribution, seasonal variety, and vigor shall be evaluated on the basis of the results which could reasonably be expected using methods of revegetation approved by the regulatory agency.

On the Buckskin site, analysis indicates that, over the long term, soil productivity would stabilize at 94% of premining levels, thereby reducing vegetative productivity proportionately.

COMMITTED MEASURES

(A) The daily use of the access road by Buckskin mine employees would generate fugitive dust emissions along the length of the road outside of the mine property. In order to keep these emissions to a minimum the applicant has agreed to put a chip-and-seal surface on the access road. This would reduce the generation of fugitive dust from access road traffic by 85%. Thus, 0.77 pounds of dust per vehicle mile traveled would be expected, as opposed to 5.16 pounds per vehicle mile traveled if the access road were not chipped and sealed. Annual emissions from the access road would be reduced from 206 tons per year to 31 tons per year. Paving of the access road satisfies best management practice as required by the Environmental Protection Agency (EPA). EPA in-

terprets best management practice as those procedures or techniques that can be reasonably (determined on a case-by-case economic basis) used to control fugitive dust.

(B) Piles of rocks and boulders placed on reclaimed areas will replace destroyed rock outcrops (microhabitats) which provide wildlife cover. These outcrops should be placed at a rate which will yield a level or density approximating premining occurrence.

Mining would eliminate rock outcrops and other types of cover which provide areas for concealment, dens, and/or nesting, and the reclaimed portion of the site would be lacking cover until shrub species are reestablished.

This measure would reestablish the microhabitats, and would also relieve some of the "smoothened"appearance of topography after reclamation. The feasibility of this measure is dependent upon the number of rocks and boulders available in the overburden material.

(C) Small reservoirs or depressions will be established during the reclamation of Spring Draw and Rawhide Creek for the collection of water, which will add to the value of the land for postmining land use. The Wyoming Department of Environmental Quality (DEQ) requested this measure in a letter to the permittee dated October 26, 1977.

The destruction of pools of standing water in Rawhide Creek due to mining activities would eliminate resting and nesting areas for waterfowl and shore birds and some essential life-sustaining areas for amphibians and some reptiles. It would also eliminate a primary source of drinking water for livestock, birds, and wildlife in the area of the mine.

If the retention of an equivalent amount of surface water can be maintained by artificially constructed pools, then the impact described would be almost totally reduced, with the exception that until aquatic and riparian vegetation becomes naturally established around these pools, the pools would not be as attractive to wildlife as they are presently.

(D) The mine operator will institute fire prevention and fire-fighting training programs as a part of the safety program. These training programs would have an indeterminate effect on reducing fire hazards and environmental and economic losses due to wildfire.

(E) Bureau of Land Management (BLM) fencing specifications which will allow deer and antelope migration will be used for fencing the mine and railroad spur. Woven-wire fences will be acceptable only where the animals must be excluded from a portion of the mine for their safety. DEQ requested this measure in a letter to the permittee dated October 26, 1977.

Use of three-wire fence with a maximum height of 38 inches and a smooth, barbless wire 16 inches above the ground would alleviate about 75% of the antelope and deer loss from entanglement in fences, entrapment during winter storms, or prevention of movement to areas of available food and water. Such fencing would lose some of its mitigating effect during the winter if snow depth is above the bottom wire and animals are forced to jump fences.

(F) Based on discussions with the Wyoming State Engineer's Office (personal communication, Paul Thompson 1978), as a condition on the issuance of a water channel diversion permit, the diversions constructed at Buckskin would have to be designed to accommodate the runoff resulting from back-to-back (24-hour) 100-year storms.

This type of engineering design would alleviate much of the potential for breaching of the diversion channel when runoff reaches the flood stage. This measure would also minimize secondary impacts to soils, water quality, and downstream vegetation.

Cultural Resources

Protective stipulations for both known and unknown archeological sites have been drawn up by the Wyoming State Archeologist and the Bureau of Land Management (BLM). These stipulations are subject to comment by the Advisory Council on Historic Preservation.

Wyoming State Archeologist

(G) The proposed stipulations of the Wyoming State Archeologist for protection of known sites state, "No terrain altering activities should take place outside the proposed railroad corridor near 48 CA 89. This includes vehicular travel. If it is necessary to deviate from the present corridor, then additional archeological studies will be needed" If construction or vehicular traffic outside the railroad right-of-way is necessary, the Wyoming State Historic Preservation Officer and the District Manager, BLM, will be notified to complete studies and/or salvage of the tipi ring site.

The stipulations also state, "No construction or vehicular traffic should be allowed within 25 yards of 48 CA 130. Since 48 CA 130 is highly visible, care should be taken to prevent curiosity seekers, collectors, and other potential looters from digging in the site. Care should also be taken to assure that construction design does not cause new erosion to the shallow cultural deposits. If the site cannot be protected adequately, then additional studies, possibly complete salvage, will be necessary" The Wyoming State Historic Preservation Officer and the District Manager, BLM, will be notified if it is deemed necessary either to disturb the site during railroad spur construction and/or if vandalism by construction workers is likely. The permittee has added a disclaimer to the latter stipulation (letter from Shell, dated 1/14/78) saying that the company cannot be responsible for actions of people other than Shell personnel, since the land is privately owned and beyond their control.

These measures will be enforced by the regulatory authority and should be effective in protecting the known sites.

(H) As yet unknown archeological sites will be generally protected by the Wyoming State Archeologist. He proposes that a professional archeologist will observe and monitor topsoil removal on each side of Rawhide Creek, that the Wyoming State Historic Preservation Officer will be notified of any cultural resources unearthed

during mining or construction, and that such resources will be protected until investigations can be made by a qualified archeologist.

This measure will be enforced by the regulatory authority. A qualified archeologist acceptable to the regulatory authority will be contracted by the permittee to be present during the initial surface disturbance of all of those areas of alluvial or wind-laid deposits identified in the inventory. Should a site or sites of National Register significance be encountered, appropriate mitigation will be conducted in consultation with the State Historic Preservation Office and Advisory Council. The archeologist will test sites uncovered to aid his or her professional judgement of the quality of such sites. The permittee may opt to conduct trenching and/or bore test holes on identified sensitive areas prior to mining or surface disturbances using an archeologist and acceptable methodology. Upon finding any type of cultural site, the operator will contact the regulatory authority.

The effectiveness of this measure depends on the amount of destruction a site would sustain as it is uncovered, and the ability and willingness of workers to recognize and report subsurface sites.

Bureau of Land Management

Stipulations proposed by the Bureau of Land Management are as follows:

(I) Periodic monitoring of known sites by BLM archeologist to check for weather-induced deterioration or vandalism.

(J) Stabilization of site 48 CA 130 and physical protection consisting of burial beneath sterile material. Stabilization and burial methods will be specified by BLM.

(K) Establishment of physical access controls (such as fencing and locked gates) along the railroad right-of-way to protect site 48 CA 89.

(L) Development of a subsurface testing program to ascertain if buried cultural resources exist along the portion of Rawhide Creek that crosses the lease.

TABLE BU4-1
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
AIR QUALITY					
Generation of fugitive dust emissions would cause an increase in total suspended particulates (TSP)	-	(A) paving of access road	-	will reduce 85% of dust on access road	fugitive dust emission from the entire project would be reduced by 14%-23%
Visibility would be reduced by increased TSP	-	(A) paving of access road	-	will reduce 85% of dust on access road	visibility impacts would be lessened by an unknown amount
Slight amounts of NO_2, SO_2, and HC would be generated by vehicles	-	-	-	-	impact unchanged
GEOLOGY					
Part of the geologic record would be lost	-	-	-	-	impact unchanged
Ground stability would be decreased	-	-	-	-	impact unchanged
Rock hunting would be increased	-	-	-	-	impact unchanged

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
PALEONTOLOGY					
Potential fossil bearing strata would be lost	-	-	-	-	impact unchanged
Unauthorized fossil collecting would increase	-	-	-	-	impact unchanged
TOPOGRAPHY					
Smooth depressions would result after mining	-	(B) placement of rock outcrops	-	outcrops will alleviate smoothness of terrain	depression would be smooth with some irregular outcrops
Landforms would be altered during mining	-	-	-	-	impact unchanged
Some railroad and road cuts may remain after mining	-	-	-	-	impact unchanged

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
SOILS					
Soil productivity would be reduced after reclamation	30 CFR 715.13 30 CFR 715.16	-	soils handling and postmining land use	soil productivity on this site can only be restored to 94% of original productivity	6% long term loss of soil productivity
Soil productivity would be lost for new urban areas	-	-	-	-	impact unchanged
Soil productivity would be lost while areas are being mined	-	-	-	-	impact unchanged
Topsoil would be lost to erosion	30 CFR 715.16 30 CFR 715.20	-	topsoil handling and revegetation	90-95% of topsoil can be retained on the site	5-10% loss of topsoil during mining
Topsoil could be contaminated by toxic materials	30 CFR 715.16	-	topsoil handling	operator shall redistribute topsoil to prevent excess contamination	some contamination could still occur

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
GROUNDWATER					
Water quality would be lowered in spoils after reclamation	30 CFR 715.17	-	overburden back-filling monitoring	SMCRA requires "minimization" of water quality reduction	water quality in the spoils would probably be reduced to some extent
Water levels would be lowered in adjacent aquifers during mining	30 CFR 715.17	-	water supply, water monitoring	the operator will be required to replace water supplies lost to neighboring water users	water levels would still drop, but users would not be adversely affected
Valley floors designated as alluvial could be disturbed	30 CFR 715.17	-	various portions of entire M&R plan	in alluvial valley floors, operator must identify and study "essential hydrological functions" and either conduct operations to preserve these functions, or avoid mining such valley floors	in alluvial valley floors, "essential hydrologic functions" would be preserved

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
Water levels would be nearer the surface in spoils	30 CFR 715.14 30 CFR 715.17	-	overburden backfilling and grading monitoring	operator must monitor and conduct operations to minimize disturbance of hydrologic balance	water levels could still be nearer the surface
Infiltration and recharge would be altered in the spoil after reclamation	30 CFR 715.17	-	reclamation portion of plan, monitoring	reclamation will be conducted to restore "approximate" premining recharge capacity	infiltration and recharge could still be somewhat altered, but adverse effects are minimized
Coal and overburden aquifers would be destroyed by mining	-	-	-	-	impact unchanged
Consumptive use of groundwater could affect other users	30 CFR 715.17	-	water supply and monitoring	the operator will be required to replace water supplies lost to neighboring water users	other users will not be adversely affected

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
SURFACE WATER					
Surface water system would be destroyed by mining, water will be diverted around the mine	30 CFR 715.17	-	diversion channel	temporary diversion channels will be built to prevent changes in water quality and quantity	during mining, original system would be lost, but surface waters would be diverted in a manner to retain quantity and quality
After reclamation, surface water system would be altered from existing characteristics	30 CFR 715.13 30 CFR 715.14 30 CFR 715.17	(C) restoration of reservoirs	various portions of reclamation plan	changes in water quality, quantity and location shall be minimized to support postmining land use	surface water system characteristics could still be altered from existing ones, but adverse affects would be minimized
Shallow ponding could result after reclamation	30 CFR 715.13 30 CFR 715.14 30 CFR 715.17	-	overburden backfilling and grading, postmining land use	operator will conduct operations to minimize disturbance of hydrologic balance	shallow ponding could result in the long term due to settling of overburden

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
Peripheral gullying could result after reclamation	30 CFR 715.13 30 CFR 715.14 30 CFR 715.17	-	overburden back-filling and grading, postmining land use	slopes are to be equal or less than pre-mining slopes, this would eliminate 95% of gullying	some gullying (5%) would occur on slopes
During flooding, sedimentation would increase due to high stream velocities	-	-	-	-	impact unchanged
Breaching of bypass channel and impound-ments would release low quality water downstream	30 CFR 715.17	(F) diversion channel design	diversion channels and impoundments	diversion channels and impoundment are to be built to pre-vent changes in water quality	maximum flooding could still result in some breaching
Leachate and surface runoff could enter to surface water system during mining	30 CFR 715.17	-	sedimentation control, water monitoring	best control technology will be applied to control pollu-tion from runoff waters	reduction in water quality could occur, but adverse effects would be minimized

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
Increased surface water use by new population	-	-	-	-	impact unchanged
Water quality could be lowered by sewage effluents	-	-	-	-	impact unchanged
VEGETATION					
Vegetative productivity would be reduced after reclamation	30 CFR 715.13 30 CFR 715.16 30 CFR 715.20	-	topsoil handling revegetation, postmining land use	productivity levels can be restored on this site to 94% of pre-mining levels on this site	6% long term loss of vegetative productivity
Vegetative productivity would be lost for new urban areas	-	-	-	-	impact unchanged
Vegetative productivity would be lost while areas are being mined	-	-	-	-	impact unchanged
Species variety would reduced	30 CFR 715.20	-	revegetation	operator must establish a vegetative cover of a seasonal variety native to the area	grasses would be more successful initially, resulting in lack of variety in the short term

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
Vegetative productivity could be reduced by increased dust during mining	-	(A) paving of access road	-	will reduce dust from access road by 85%	reduction in vegetative productivity would be mitigated by an unknown amount
Fire hazard would be increased during mining	-	(D) fire prevention and control training	-	unknown	would likely reduce hazard and loss from wildfire
Aquatic vegetation would be adversely affected	30 CFR 715.13 30 CFR 715.14 30 CFR 715.17	-	reclamation portion of plan	surface water system will be reclaimed to minimize impact on water quality, quantity and location	aquatic vegetation would be lost during mining, but reestablishment of surface water system may allow vegetation to reestablish itself
Vegetative productivity could be reduced by topsoil erosion	30 CFR 715.16 30 CFR 715.20	-	topsoil handling and revegetation	90-95% of soil can be retained on site	some reduction in vegetative productivity could result from loss of 5-10% of topsoil

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
WILDLIFE					
Wildlife habitat quality would be reduced after reclamation (affecting populations and carrying capacity)	30 CFR 715.13	(B) placement of rock outcrops (C) restoration of reservoirs	postmining land use	cover (rock outcrops) and watering will be somewhat restored, vegetative productivity can only be 94% restored on site	some habitat would be restored but 6% of vegetative productivity (carrying capacity) would be lost in the long term
Wildlife habitat would be lost during mining	-	-	-	-	impact unchanged
Carrying capacity would be lost during mining	-	-	-	-	impact unchanged
Wildlife populations would be lost	-	(E) use of BLM fence specifications	-	75% effective in reducing animal deaths along fences	wildlife populations would be lost by displacement during mining, with some re-population following mining, only 25% of game animal deaths on fences would occur

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
CULTURAL RESOURCES					
Known cultural sites could be damaged by mining activities	-	(G) (I) (J) (K) protection of known sites	-	damage to known sites will be prevented	no impact
Unknown sites could be uncovered and/or damaged by mining activities	-	(H) (L) protection of unknown sites	-	would aviod or reduce loss of subsurface sites	sites may be damaged in initial uncovering and may be lost if not immediately reported to archeologist
Cultural artifacts could be damaged or lost by increased, unauthorized collecting	-	-	-	-	impact unchanged
VISUAL RESOURCES					
Visual quality on the mines site would be reduced from Class IV to Class V	-	-	-	-	impact unchanged

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
Visual quality in new urban areas would be reduced from Classes II, III, or IV to Class V	-	-	-	-	impact unchanged
RECREATION					
Use of recreation facilities would be intensified	-	-	-	-	impact unchanged
"Primitive" recreation quality would be reduced	-	-	-	-	impact unchanged
Conflicts between landowners and recreationists would increase	-	-	-	-	impact unchanged
Numbers of huntable wildlife would be reduced	-	-	-	-	impact unchanged
Mining and urban increase would reduce the land use base	-	-	-	-	impact unchanged

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
Sightseeing of natural landscapes would be reduced	-	-	-	-	impact unchanged
AGRICULTURE					
AUMs (carrying capacity) would be reduced after reclamation	30 CFR 715.13	-	revegetation, post-mining land use	vegetative productivity can only be 94% restored on this site	long term loss of 6% of carrying capacity
AUMs would be lost while areas are being mined	-	-	-	-	impact unchanged
AUMs would be lost for new urban areas	-	-	-	-	impact unchanged
Forage productivity could be reduced by dust fallout	-	(A) paving of access road	-	will reduce dust from access road by 85%	reduction of forage productivity would be lessened by an unknown amount
Animal harrasment and unintention openings of enclosures would increase	-	-	-	-	impact unchanged

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITITATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
New rail and road access could split pastures and interrupt agricultural operations	-	-	-	-	impact unchanged
Surface water system alteration would affect agricultural operations	30 CFR 715.13 30 CFR 715.17	(C) restoration of reservoirs	reclamation portion of plan	surface water system will be reclaimed to minimize impact on water quality, quantity, and location	adverse impacts on agricultural operations would be minimized
Increased sediment release during floods would affect productivities	-	(F) diversion channel design	-	-	only maximum flooding would cause sedimentation downstream
121 acres of cropland would be destroyed and not reestablished by reclamation	30 CFR 715.13	-	reclamation portion of plan	reclamation will restore lands to the uses they were capable of supporting prior to mining	unknown

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITIGATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
MINERAL RESOURCES					
Coal would be converted to electrical energy	-	-	-	-	impact unchanged
Some coal would not be recovered by mining technology	-	-	-	-	impact unchanged
Sand, gravel, and scoria would be consumed in construction activities	-	-	-	-	impact unchanged
TRANSPORTATION					
Rail traffic would increase	-	-	-	-	impact unchanged
Street and highway traffic would increase	-	-	-	-	impact unchanged
Traffic and use of the Gillette airport would increase	-	-	-	-	impact unchanged

TABLE BU4-1
(cont'd)
EFFECTIVENESS OF MITICATION AND RESIDUAL IMPACTS

Description of Impact of Proposed Action	SMCRA* Requirement (30 CFR 700)	Committed or Enforceable Mitigating Measure	Phase of Proposed Action Potentially Requiring Change or Addition (for SMCRA only)	Indication of Effectiveness & Feasibility	Residual** Impact
SOCIOECONOMICS					
City of Gillette would experience increased fiscal stress	-	-	-	-	impact unchanged
Housing requirements and needs would intensify	-	-	-	-	impact unchanged
Quality of life and character of Cillette and Campbell County would be changed	-	-	-	-	impact unchanged
Employment and wages would increase	-	-	-	-	impact unchanged

* Surface Mining Control and Reclamation Act of 1977. Regulations cited were published in final form in December 1977.

** "impact unchanged" entries in this column indicate no change from the impacts due to the proposed action.

CHAPTER 5

UNAVOIDABLE ADVERSE IMPACTS OF THE PROPOSED ACTION

The following adverse impacts of the proposed action would remain after application of the mitigating measures discussed in Chapter 4. Whether certain impacts (such as those related to visual resources or socioeconomics) are adverse is a matter of personal preference. To the long-time resident who cherishes a traditional lifestyle, change probably would be adverse. To new residents, and those interested in economic and urban development, signs of growth would probably be welcome.

Impacts are listed in their general order of significance.

The population increase attributable to the Buckskin Mine would be 843 by 1990, of which about 87% would live in Gillette. One additional policeman and ten additional teachers would be needed to serve these people. The incremental effect of Buckskin-related population increases on other community services (e.g., water, fire protection, health) in Gillette would be insignificant compared to the effect of total regional development.

The population increase due to Buckskin would comprise 6% of the total increase expected in Gillette by 1990. There would be corresponding increased pressure on the housing market and transportation facilities.

The Buckskin project would increase regional earnings by $14.2 million by 1990 (2.4% of total increase in regional earnings expected by 1990), contributing to local inflationary pressures and reducing the buying power of people on fixed incomes.

Coal train traffic, producing noise and traffic congestion, would amount to 14 unit trains (both ways) per week from the Buckskin Mine by 1990, or 2.3% of regional coal traffic.

The projected increase in the number of registered vehicles in Campbell and Converse counties as a result of Buckskin is 770, or about 3.7% of the total predicted increase for those counties.

Lowering of water levels would occur in the overburden and coal in the vicinity of the Buckskin Mine until mining is completed. The bottom of the coal (bottom of the mine) would be the water discharge point. The cone of depression would extend 1,000 to 1,500 feet in the overburden and 3 miles in the coal. Groundwater levels would be lowered an unquantifiable amount in the vicinity of municipal wells to supply the Buckskin-related population.

Disruption of the shallow groundwater system would eliminate lush foliage along Rawhide Creek and Spring Draw, as well as some point-watering sources both within the mined area and for a distance of probably no more than 3 miles beyond it. These effects may last only for the life of the mine, or, depending on the relation of the reclaimed surface to the water table in the mined area, be permanent. Loss of point-watering sources would discourage stock and wildlife grazing in the area.

Water in replaced spoils would be higher in total dissolved mineral levels (e.g., calcium, magnesium, and sulfate ions) than in the original aquifers. Such changes may render the water unsuitable for drinking or irrigation.

Gillette's water and sewage treatment needs would be substantial by 1990, but would not be significantly affected by the Buckskin-related population increase.

Erosion and consequently sedimentation within the mine area would be greatly increased. Water erosion of soil from disturbed areas would amount to 10 to 30 tons per acre per year, or an increase of 5 to 25 tons per acre per year over rates from undisturbed land. Leachate from spoil piles and replaced overburden would reduce surface water quality (see Table R4-5 in the regional analysis). Only a small portion of these impacts would be felt beyond the mine areas, unless very heavy storms (e.g., 100-year floods) cause breaching of the catchments and settling ponds.

Ponding of surface and/or groundwater may occur after reclamation in depressions as the overburden settles. The water quality may be too poor for stock or wildlife, particularly if the depressions intercept groundwater as well as collecting surface runoff. If ponding occurs on the reclaimed area due to interception of groundwater by the lowered ground surface, then a lake could form, removing 35 to 40 acres (depending on the degree of settling) from vegetative or agricultural production. Terrestrial wildlife habitat would be exchanged for aquatic, although the water quality in the lake could be too poor to support animal life.

By the end of the mine life, temporary disturbance of soil, vegetation, and wildlife habitat would occur on a total of 1,071 acres, causing loss of soil and vegetative productivity an average of 10 years and loss of wildlife carrying capacity for more than 10 years. By the end of mine life, permanent disturbance would occur on 45 acres where new houses are constructed for the mine-related population. In comparison, total acreage disturbed temporarily and permanently in the region by 1990 would be 59,403 and 3,242 respectively.

Soil productivity on reclaimed areas would be an estimated 94% of present levels. This is because significant amounts (20% to 30%) of the soil material used in reclamation would be of poor quality, due to high salinity or alkalinity, or high clay content. (No better soil material is available to replace the poor quality soil.) Such materi-

al would inhibit or prevent revegetation, thus increasing erosion rates. Also, a 20% to 40% reduction in quality would occur in stockpiled topsoil due to the loss of seeds, microorganisms, organic matter, nutrients, and roots.

Accidental spillage of oil, gas, or other toxic materials would contaminate small amounts of soil, but such spillage would be localized and of little relative significance. Wind and water erosion would cause the loss of 5% to 10% of available topsoil material. Wind erosion of soil from the Buckskin site would amount to 85 to 110 tons per year, an increase of 70 to 90 tons per year over rates from the undisturbed area. As mentioned before, water erosion of soil would amount to 10 to 30 tons per disturbed acre per year.

The return of agricultural land to production after reclamation depends on the success of revegetation efforts. Assuming that livestock range production can be restored by 94%, a permanent loss of 6% production capability (11 animal unit months (AUMs)) annually would occur over premining levels. An additional permanent impact would be the loss of 8 AUMs annually on the 45 acres where new houses are constructed. An estimated 256 AUMs would be lost annually on the mine site for the life of the mine, for a total loss of 5,120 AUMs.

Vegetation on the Buckskin site presently consists of 65% shrub types and 35% grass types. About 70 different species were identified during Shell Oil's plant survey in the summer of 1976. After reclamation, vegetation is expected to consist of no more than 25% trees and shrubs and 75% grasses, and diversity would be much less (about 15 species, at least until native species invade the reclaimed area—see Chapter 1 for proposed seeding mixture). Lack of vegetative diversity reduces stability of the vegetative community and the variety of wildlife it supports.

Due to the proposed action, 121 acres of cultivated land would be lost. After the 121 acres are reclaimed for grazing, there would be a gain of 19 AUMs annually.

The increased population due to Buckskin (815, or about 4% of total increases in Campbell and Converse counties by 1990) would cause a corresponding increase in dispersed recreation activities (leading to possible adverse impacts to ranching operations), in the use of recreation facilities, and in degree of loss of the "primitive"recreation experience.

Wildlife habitat diversity and habitat interspersion would be greatly reduced. The edge between major habitat types would be reduced by 61.25% from 24.67 miles in the premining habitat to 9.56 miles in the postmining habitat. This would have a resultant negative effect on wildlife diversity in the postmining habitat. Special habitat features such as small cliffs and rock outcrops would be lost and only partially replaced.

Wildlife populations currently living on the site would be lost. This would be significant locally, but compared to regional populations, the losses from this mine would be insignificant. The possibility of cutting off some preferred winter range for pronghorn south of the mine would exist.

The mine pit, stripped areas, machinery, buildings, and support structures (power lines, railroad spur, and access road) would be visual intrusions in the characteristic landscape until abandonment and revegetation is complete.

The proposed action would result in the mining and consumption of 80 million tons of coal and an amount of sand, gravel, and scoria (clinker) estimated to be over 80,000 cubic yards. In addition, 2.6 million tons of coal, which is mixed with overburden or partings, would be unrecoverable by present mining methods.

Two cultural resource sites would be destroyed by the proposed action, and some information may thereby be lost, even with salvage.

Two other sites, determined eligible for nomination to the National Register and within the railroad spur right-of-way, might be subject to damage.

The approximately 4% increase in population due to Buckskin would contribute correspondingly to unauthorized collection or vandalism of cultural and paleontological resources.

Natural topography would be altered by the mine pit and cuts and fills, and then reclaimed to unnaturally smooth contours. Replaced overburden would be unstable, tending to settle or shift over time, making it unsuitable for construction of permanent buildings. Even though a part of the topographic scene, cannot be restored.

Predicted annual total suspended particulate (TSP) concentrations would not be expected to exceed 15 micrograms per cubic meter beyond 1.5 miles south or north of the mine boundary with even less impact east and west of the mine boundary. Violations of the Wyoming air quality standards would not be predicted. No measurable effect on visibility would be expected outside the proposed mine boundary.

Gaseous pollutants (nitrogen and sulfur oxides and hydrocarbons) from vehicle emissions at the mine would have only a minute effect and be restricted to the immediate area of the mine.

CHAPTER 6

RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

Approval of the Buckskin mining and reclamation plan would allow mining of 80 million tons of coal over a 20-year period to meet national energy demands. Although Buckskin would be a new mine, coal mining is not new to Campbell and Converse counties. There are already fifteen coal mines in the region either operating or pending final approval, and the Buckskin site is only 2 or 3 miles from the currently operating Rawhide Mine. The proposed Buckskin Mine site is presently used for livestock grazing, and it could be returned to that use after reclamation.

The coal removed from the Buckskin Mine by 1990 would amount to 42 million tons (2% of all coal mined in the region by 1990); it would be consumed in the production of electricity outside the region. About 2.6 million tons of coal would be lost at the Buckskin Mine by the end of mine life, because current mining technology does not permit its economic separation from overburden and partings.

The 1978 population of Campbell and Converse counties is estimated at 37,780. By 1990, population increases in these counties due to the Buckskin project would amount to 815, or 3.8% of total increases expected in these counties by 1990.

In the short term, the Buckskin Mine would contribute to increased local income and stimulate retail and wholesale trade. The loss of buying power of people on fixed income would be a long-term effect.

Permanent employment at the Buckskin Mine would reach 133 by 1990; this project alone probably would not create a labor shortage in other sectors of the economy, although it would contribute (3.4% by 1990) to the effect of total regional mine employment. In the long term, the regional labor force would grow to meet the demands of all employers, and increased employment would tend to hold the unemployment rate at its current low level. At the end of the Buckskin Mine life, it is expected that the employees could find work at other mines in the region.

In the short term, the population increase attributable to the Buckskin Mine would contribute to community problems; in Gillette, the Buckskin-related population increase by 1990 would amount to 6% of total community growth expected. Rising housing prices and crowded conditions, crowding of classrooms, increased pressures on health care and transportation facilities, and overtaxing of local services would occur. However, in the long term, housing stock would increase to meet demand; new facilities would be built and personnel to man them would be hired; the tax base would increase to pay for these needs.

Since the Buckskin Mine site could be reclaimed, mining would represent a short-term commitment of land use. Following reclamation, construction of buildings on the site might be restricted due to decreased ground stability. Land occupied by expanded urban areas (45 acres to serve Buckskin-related population increases) would be permanently committed.

Short-term disturbance of the soil resource would disrupt the productivity levels, destroy existing soil profiles, and increase soil erosion losses on 1,071 acres by the end of mine life. Soil productivity levels could be restored in the long term to an estimated 94% of premining levels.

Development of the Buckskin Mine would result in short-term losses of vegetation on 1,071 acres by the end of mine life. Reestablished vegetation could support livestock grazing within 10 years after reclamation begins, and in the long term, productivity would probably stabilize at 94% of premining levels.

The use of 45 acres for housing and support services for the Buckskin-related population increase would be a long-term commitment of the land. Productivity in relation to soils, vegetation, livestock grazing, and wildlife habitat would be lost, but productivity as measured in benefits to people would be enhanced.

A total of 1,071 acres of wildlife habitat would be lost for the short term at the mine site. Habitat diversity would be reduced, because areas formerly dominated by big sagebrush and silver sagebrush would be reclaimed to grassland. The riparian habitat along Rawhide Creek and Spring Draw would be lost and replaced by grassland with a few shrub species. The edge between major habitat types would be reduced by 61% after reclamation compared to the premining habitat. Existing wildlife populations on the site would be lost as their habitat is destroyed. Repopulation of reclaimed areas by small nongame mammals, birds, and reptiles should occur. The rate of repopulation and postmining densities are currently unpredictable.

The loss of 256 animal unit months (AUMs) of grazing annually would be a short-term loss.

Salvage of the two cultural resource sites within the area to be mined would be a long-term commitment.

CHAPTER 7

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES CAUSED BY THE PROPOSED ACTION

Approximately 80 million tons of coal would be extracted and consumed as a result of approval of the proposed action. An additional 2.6 million tons would be left as unrecoverable by present mining methods and lost.

The population and wage increases attributable to Buckskin would contribute to the change in life-style occurring in the region.

Loss of human life due to rail, highway, or mine accidents would be irreversible and irretrievable. The estimated potential fatality rate for coal strip-mining is 1 per 14.3 million tons of coal produced or 5 to 6 lives for the 80 million tons of coal produced.

Destruction of the physical structure of the premining aquifers would be irreversible. Water in aquifers which develop after reclamation would be of poorer quality than in the premining aquifers. This, in turn, may mean poorer surface water quality for some years following mining.

Some premining point-watering sources along Rawhide Creek and Spring Draw would be destroyed; the resulting loss in water source density and dispersion could cause a reduction in wildlife habitat and grazing range.

Existing soil associations on 1,071 acres would be destroyed. Soil loss to erosion or contamination by toxic materials would be irreversible.

Soil and vegetative productivity on 45 acres would be irreversibly lost to new homes, and 6% of the land's premining productive capability would be lost on 1,071 reclaimed acres.

If significant ponding of water on the settled overburden occurs, there would be further irretrievable loss of soil and vegetative productivity and of wildlife habitat on 35 to 40 acres.

There would be an irretrievable loss of vegetative production, approximately 256 animal unit months (AUMs) annually, and total wildlife carrying capacity on 1,071 acres for the life of the mine.

Wildlife which presently occupies the mine site would be displaced and lost, as would subsequent generations of offspring (see Table BU3-13).

Forty-five acres of wildlife habitat would be permanently lost due to construction of new homes.

The aquatic habitat which presently exists on the mine site would not be replaced, but a different community would reestablish itself.

Houses, service facilities, utilities, and roads built on approximately 45 acres to accommodate the increased population would irreversibly commit visual resource Class II, III, and IV areas to Class V.

The land surface on the mine site, which includes cliffs, abrupt breaks, and rolling hills, could not be restored to its original conformation.

Cultural resources in areas of surface disturbance would be committed to either destruction or salvage; in either case, additional information would not be available to future researchers.

The removal by amateurs of collectible minerals, fossils, or cultural resources would be an irreversible loss.

CHAPTER 8

ALTERNATIVES TO THE PROPOSED ACTION

The Geological Survey accepted the Buckskin mining and reclamation plan as adequate for environmental review and subsequent approval under the 30 CFR 211 regulations of May 1976. However, as discussed in earlier parts of this analysis, this plan requires revision to comply with the recently enacted Surface Mining Control and Reclamation Act of 1977 (SMCRA).

In acting on this mining and reclamation plan, the Secretary of the Interior's action may be: approval after specific requirements have been met, or rejection on various environmental or other grounds. He may also defer decision pending submission of additional data, completion of required studies, or for other specific reasons.

Even after a mining and reclamation plan is approved, the regulations and lease terms require that all subsequently proposed departures and deviations therefrom be approved in advance by the Secretary. The regulations (30 CFR 211 and 700) also permit the Secretary to direct that changes be made in previously approved operations. For example, changes could be ordered to accommodate new, improved, or revised administrative requirements, technologic improvements, environmental concerns or requirements, or revisions of prior evaluations thereof in the light of experience or previously unknown factors.

REJECTION (NO-ACTION) ALTERNATIVE

"No action"on a mining proposal for the initial development of an existing federal lease would result in maintaining the status quo on the lease. Should no action be taken on the Buckskin mining and reclamation plan, the anticipated markets would have to locate another source to supply 80 million tons (4 million tons annually) of low-sulfur coal.

If no action is taken on the mining plan, and if current land use of the area continues, most resources on the proposed Buckskin site would remain essentially unchanged. Some decrease in air quality could be anticipated due to urban expansion, increased traffic, and the development of other mines. Imperceptible alterations in soils and topography might occur by 1990 due to natural forces such as eorsion. Increased hunting, rockhounding, and off-road vehicle use may occur on the site with or without landowner permission, due to the pressure of regional population increases.

No action on the mining plan would also cause: (1) retention of 84 million tons of low-sulfur coal reserves for future use, (2) retention of 1,071 acres of surface and subsurface features on the site in essentially their present state (some of this land is within the Carter Oil Company mine permit area, and may be disturbed in the future), and (3) alleviation of some adverse sòcioeconomic impacts on the city of Gillette and nearby towns.

ALTERNATIVE TO APPROVE MINING AND RECLAMATION PLAN AFTER SPECIFIC REQUIREMENTS HAVE BEEN MET

The mining and reclamation plan can be approved only after it has been modified to meet all applicable regulations.

Specific modifications or requirements could be applied to the approved plan which would reduce some of the impacts described in Chapter 5.

Condition Approval Upon Demonstration of Successful Reclamation

The mining and reclamation plan would be conditionally approved for a period of 10 years during which time a specific testing and monitoring program for the purpose of measuring revegetation success would be implemented by the coal mining company. In this alternative a plan describing the testing and monitoring program would be prepared by the Shell Oil Company for approval by the regulatory authorities prior to its implementation.

If it cannot be demonstrated that revegetation can be successful commensurate with SMCRA at the conclusion of the 10-year program, the Department of the Interior will revoke its approval for mining.

Although current reclamation research indicates that successful reclamation can be achieved on semiarid mined lands, it is recognized that answers to reclamation problems are needed on a site-specific basis in order to ensure success.

This alternative, if implemented, would result in the gathering of data to show that lands proposed for mining are reclaimable within a reasonable period of time.

Shell Oil Company would be required, under the direction of state and federal reclamation regulatory agencies, to establish a suitable number of demonstration plots to provide evidence of revegetation success.

The demonstration plots would be established as soon as practicable following authorization to commence mining operations.

Impacts which would occur if revegetation could not be accomplished follow.

1. The mining company would be forced to shut down its operation.

2. A shut-down of the mine would cause loss of employment for most of the employees and partial loss of investment in material needed to open and operate the mine for the 10-year period.

3. Areas disturbed during the 10-year period of mining would be reclaimed to a lesser productivity than the law requires.

Fish and Wildlife Mitigation Alternatives

The recommendations which follow would reduce or eliminate the major impacts to existing fish and wildlife resources described in Chapter 3.

(1) All mining areas would be reclaimed to wildlife habitat as soon as feasible. Reclamation would be in conformance to the postmining land use established by the State of Wyoming (Department of Environmental Quality) and/or the Bureau of Land Management. Vegetative planting and reclamation would be accomplished in consultation with the Wyoming Game and Fish Department. The goal of reclamation should be to achieve the highest possible wildlife carrying capacity at the earliest possible date, using all reasonable means.

(2) Approximately 1,500 acres of land lying in a suitable area where public domain (or private land under cooperative agreement) is available should be set aside and managed intensively for fish and wildlife resources. Selection of such an area should be accomplished in consultation with the Wyoming Game and Fish Department. The area set aside should be managed to increase its wildlife carrying capacity by at least 50%. Management tools such as water development, fertilization, vegetative manipulation, spraying, transplanting, seeding, protection of wildlife cover, and management of livestock grazing to enhance wildlife habitat should be implemented as necessary. The habitat should be controlled by the surface-management agency and wildlife by the Wyoming Game and Fish Department.

(3) It would be provided that a mine permit will not be granted on land critical to the ecological requirements of the bald or golden eagle. A team of qualified biologists from the Wyoming Game and Fish Department and the Bureau of Land Management will judge and recommend the areas to be excluded from mining. A mine permit could be granted if regulations are adopted to provide for buffer zones and alternate prey bases and nesting sites, and if that acreage critical to the eagle is not affected.

Alternative to Increase Rate of Production Over A Shorter Mine Life

The following alternative was suggested after the draft ES was published, and hence has not been subjected to public review. Because of time constraints, a complete impact analysis of this alternative could not be done.

Shell Oil Company has suggested, in its revised mining and reclamation plan, an alternative to the proposed action as a result of recent contractual commitments for the coal to be mined at Buckskin. Under this alternative, 6 million tons of coal would be mined annually, or a 50% increase in the rate of production specified under the proposed action. Total production at the mine would remain the same; however, mine life would be only 16 years instead of 20 years. The mine plan for extraction of 6 million tons annually would have to meet provisions of the Surface Mining Control and Reclamation Act, and changes in environmental impacts resulting from mine plan modifications would be more thoroughly assessed prior to plan approval.

Briefly, impacts of this alternative would be as follows. The increased production level would not significantly change the regional cumulative impacts, because projected coal production in the region is substantially greater than that from the Buckskin Mine alone.

Unleased federal coal lies immediately adjacent to the present Shell Oil Company lease. Shell has on file an application to lease this coal. Approval of this alternative would shorten the time frame within which Shell Oil Company would be requesting additional federal coal.

Some impacts would be intensified for a shorter period of time with a higher production rate and a shorter mine life.

A 50% increase in the rate of production would lead to a corresponding increase in emissions and ambient air concentrations of total suspended particulates (TSP) downwind of the mine. This means that the values given in Table BU3-5 and Figures BU3-1 through BU3-8, which are based on the 4 million tons per year production level, would be increased approximately 50%. The resulting TSP concentrations would still remain below the Wyoming and federal ambient air quality standards. (Use of best available control technology is assumed.)

If production is increased from 4 to 6 million tons annually, the number of unit trains leaving the mine site would increase from 400 to 600 annually, or from 8 to 12 a week. This would lead to a corresponding increase in impacts associated with rail traffic.

An additional 31 permanent employees would be required to produce the additional coal. This would mean an increase in population induced directly and indirectly by the Buckskin Mine of 194 people by 1990, 94% of whom would be expected to reside in Campbell County. Corresponding increases in vehicle traffic, local earnings, housing requirements, and demand for recreation facilities, public services, and health and social services would occur. After 16 years, these permanent employees would be seeking employment elsewhere.

An increase in the annual production rate would lead to an increase of 14 acres in the average acreage disturbed each year, thereby increasing the rate at which

vegetative productivity is lost, at which soil is exposed, and at which wildlife habitat is destroyed. Total acreage disturbed over the mine life would not increase. Reclamation would keep pace with mining disturbance under either production level.

Some impacts which are dependent on the total acreage disturbed at the mine site (such as those related to water resources, topography, and cultural resources) would not change with an increased production rate.

ALTERNATIVES AFFECTING THE LEASE

Alternative to Allow Development of Selected Areas Now Under Lease

This alternative would permit only selective exploration and development of portions of the lease based on anticipated adverse environmental consequences. The decision-maker has the authority and responsibility to evaluate the coal resources and impacts of mining on the lease prior to acting on the proposal. Exploration and development could be allowed only on that portion of the lease where the fewest adverse environmental consequences would occur. Weighing the trade offs of mining or precluding mining on part of the tract is part of the evaluation and decision process. Adoption of this alternative would reduce adverse effects by reducing the area in which the impacting activities could take place. Various requirements of SMCRA may, prior to action on the mining and reclamation plan, indicate a scheme of development on selected areas of the lease.

Alternative to Prevent Development on the Lease

The Secretary may reject any individual proposed activity that does not meet the requirements of applicable law and regulations under his authority, including the potential for environmental impact that could be reduced or avoided by adoption of a significantly different designed course of action by the operator. This may be accomplished by cancellation of the lease (if environmentally acceptable development is not possible), federal acquisition of the lease, or rejection of the mining and reclamation plan. Any of these would have the effect of precluding development, and the effects would be similar to those expected with the no-action alternative.

CHAPTER 9

CONSULTATION AND COORDINATION

See the regional analysis, Chapter 9, for a description of the consultation and coordination efforts involved in the preparation of the environmental statement.

APPENDIX

SUPPORTING DATA

SOILS

Arvada Series

The Arvada series is a member of the fine, montmorillinitic, mesic family of Ustollic Natrargids. Typically, Arvada soils have thin platy A2 horizons, fine-textured B2t horizons having columnar to blocky structure, and moderate accumulations of calcium carbonate, calcium sulfate, and other salts.

Typifying Pedon. Arvada fine sandy loam—grassland. (Colors are for dry soil unless otherwise noted.)

A2 0-4"—Light gray (10YR 7/2) fine sandy loam, grayish brown (10YR 5/2) moist; moderate very thin platy structure that parts to moderate fine granules; soft; very friable; vesicular; noncalcareous; mildly alkaline (pH 7.8); abrupt smooth boundary; 0 to 6 inches thick.

B2t 4-14"—Brown (10YR 5/3) clay, dark brown (10YR 4/3) moist; moderate medium columnar structure that parts to moderate medium angular blocks; extremely hard, firm, very plastic; moderate continuous waxlike coatings on faces of peds and in root channels; strongly alkaline (pH 9.2); 20% exchangeable sodium; clear smooth boundary; 8 to 14 inches thick.

B3casa 14-20"—Brown (10YR 5/3) heavy clay loam, dark brown (10YR 4/3) moist; weak medium subangular blocky structure; extremely hard, firm, very plastic; weak visible accumulation of calcium carbonate and other salts as crystals, in concretions, and in thin seams and streaks; few thin glossy patches on faces of peds; some waxlike fillings in root channels; calcareous; very strongly alkaline (pH 9.0); 20% exchangeable sodium; gradual smooth boundary; 5 to 10 inches thick.

Ccasa 20-60"—Light yellowish brown (2.5Y 6/3) heavy clay loam, light olive brown (2.5Y 5/3) moist; massive; hard, friable; moderate accumulation of visible calcium carbonate and other soluble salts as crystals, in thin seams and streaks, and in concretions; strongly alkaline (pH 8.8); 20% exchangeable sodium.

Type Location. Sheridan County, Wyoming; 650 feet south and 200 feet west of the NE corner of Section 29, T. 55 N., R. 87 W.

Range in Characteristics. Depth to calcareous material ranges from 0 to 12 inches, thickness of solum ranges from 15 to 30 inches. Average content of organic carbon in the upper 15 inches exceeds .6%. Thin A1 horizons occur in some pedons. Light-colored platy A2 horizons are generally present but are absent in some pedons. Content of coarse fragments is typically less than 5% and ranges from 0% to 15%. Mean annual soil temperature ranges from 47° to 58°F, and mean summer soil temperature ranges from 59° to 78°F. Length of time the soil temperature at 20 inches exceeds 41°F normally ranges from 230 to 305 days. Length of time (cumulative) the soil is moist in some part of the moisture control section while the soil temperature at 20 inches is above 41°F normally ranges from 56 days to 152 days, but in most years it should not be less than one-fourth or more than one-half of the time the soil is above 41°F. The A horizon has hue of 2.5Y to 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 2 through 4. It is typically clay but the percent of clay ranges from 35% to 60%, of silt from 10% to 50%, and of sand from 5% to 50%. It ranges from strongly alkaline to very strongly alkaline (pH 8.8 to 10.0) and has from 15% to 34% exchangeable sodium. Its cation exchange capacity ranges from 70 to 100 milliequivalents per 100 grams of clay. The C horizon has hue of 2.5Y to 10YR. It ranges from strongly alkaline to very strongly alkaline (pH 8.6 to 10.0) and contains 4% to 12% calcium carbonate equivalent. Exchangeable sodium typically ranges from 10% to 30% but generally decreases with depth.

Principal Associated Soils. These are the Absted, Renohill, and Ulm soils. Absted soils have less then 15% sodium in the upper part of the argillic horizon. Renohill and Ulm soils lack natric horizons.

Bankard Series

The Bankard series is a member of the sandy, mixed family of Ustic Torrifluvents. Typically, Bankard soils have calcareous, granular A horizons and strongly stratified but predominantly sandy, calcareous C horizons.

Typifying Pedon. Bankard loamy sand—grassland. (Colors are for dry soil unless otherwise noted.)

A1 0-5"—Light brownish gray (2.5Y 6/2) loamy fine sand, grayish brown (2.5Y 5/2) moist; weak fine granular structure; soft, very friable; calcareous; moderately alkaline (pH 8.0); clear smooth boundary; 4 to 8 inches thick.

C 5-60"—Light yellowish brown (2.5Y 6/3) fine sand stratified with thin lenses of sandy loam and loam, light olive brown (2.5Y 5/3) moist; the weighed average texture is loamy fine sand; single grained; soft, very friable; calcareous; moderately alkaline (pH 8.2).

Type Location. Morgan County, Colorado; 100 feet south and 210 feet east of the NW corner Section 30, T. 4 N., R. 56 W.

Range in Characteristics. The soils are typically calcareous throughout but are noncalcareous in the upper few inches in some pedons. Organic carbon in the A horizon ranges from .6% to 1.5%, but is typically less than 5%. Weak accumulations of secondary carbonate as soft concretions or seams are present in some pedons. Mean annual soil temperature ranges from 47° to 58°F, and mean summer soil temperature ranges from 60° to 78°F. The A horizon has hue of 2.5Y through 7.5YR, value of 5 or 6 dry, 3 through 5 moist, and chroma of 2 through 4. Typically the horizon has granular or crumb structure but is subangular blocky in some pedons. It is soft to slightly hard and is moderately alkaline. The C horizon has hue of 2.5Y through 7.5YR. It is moderately or strongly alkaline. Calcium carbonate equivalent ranges from less than 1% to 10% depending upon character of individual strata, but there is no distinct continuous horizon of calcium carbonate accumulation.

Competing Series and Their Differentiae. These are the Ellicott and Dwyer series. Ellicott soils are noncalcareous and formed in alluvial sediments derived from arkose formations containing a high proportion of medium and coarse angular granite sand and fine and very fine angular granite gravel. Dwyer soils have uniform texture in which organic carbon decreases uniformly with depth.

Setting. These soils are on gently sloping to nearly level floodplains and low terraces. Slope gradients typically range from 0% to about 6%. The soils are formed in calcareous, highly stratified but predominantly coarse-textured recent alluvium derived from a variety of rocks. At the type location, the average annual temperature is 48°F, the average summer temperature is 70°F. Average annual precipitation is 14 inches with peak periods of precipitation in the spring and early summer months.

Principal Associated Soils. These are the Glenberg and Haverson soils. Glenberg soils have coarse-loamy control sections. Haverson soils have fineloamy control sections.

Drainage and Permeability. Well to somewhat excessively drained; slow or very slow runoff; rapid or very rapid permeability.

Use and Vegetation. These soils are used chiefly as native pastureland, however, they are tilled in some localities. Native vegetation is scattered cottonwood, grass, and brush.

Distribution and Extent. The floodplains and low terraces of the major streams in Colorado, Wyoming, New Mexico, and parts of Montana, South Dakota, and Nebraska.

Series Established. Red Willow County, Nebraska, 1965.

Bowbac Series

Typifying Pedon. Bowbac sandy loam—rangeland. (Colors are for dry soil unless otherwise noted.)

A1 0-4"—Grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moist; moderate very fine and fine crumb structure; soft, very friable, slightly sticky, slightly plastic; many very fine and fine, common medium roots; mildly alkaline (pH 7.4); clear smooth boundary; 3 to 6 inches thick.

B21t 4-10"—Brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; weak medium and fine prismatic that parts to moderate medium and fine subangular blocky structure; hard, friable, slightly sticky, slightly plastic; common very fine and fine, few medium roots; thin, nearly continuous, thick patchy glossy coatings on faces of peds; mildly alkaline (pH 7.5); clear smooth boundary; 0 to 6 inches thick.

B22t 10-16"—Brown (10YR 5/3) sandy clay loam, dark brown (10YR 4/3) moist; strong medium and fine prismatic that parts to moderate medium subangular blocky structure; hard, firm, sticky, plastic; few very fine and fine roots; moderately thick continuous glossy coatings on vertical faces of peds and thin nearly continuous glossy coatings on horizontal faces of peds; mildly alkaline (pH 7.6); clear smooth boundary; 5 to 10 inches thick.

B3ca 16-22"—Light yellowish brown (10YR 6/4) sandy clay loam, brown (10YR 5/3) moist; weak medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky; few thin patches of glossy coatings on faces of peds; calcareous; fine soft rounded masses of secondary calcium carbonate; moderately alkaline (pH 8.2); gradual wavy boundary; 4 to 8 inches thick.

C1 22-32"—Light yellowish brown (10YR 6/4) sandy loam, brown (10YR 5/3) moist; single grained; soft, very friable; calcareous; moderately alkaline (pH 8.2); gradual wavy boundary; 8 to 12 inches thick.

Cr 32-40"—Soft, partially weathered, calcareous sandstone.

Type Location. Converse County, Wyoming; SE¼, SW¼ of Section 8, T. 36 N., R. 72 W.

Range in Characteristics. Depth to paralithic contact is 20 to 40 inches; depth to calcareous material is 10 to 20 inches. The solum is 15 to 22 inches thick. Coarse fragments range from 0% to 15%. The A horizon has hue of 2.5Y or 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 2 or 3. It is neutral or mildly alkaline. The B2t horizon has hue of 2.5Y through 7.5YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 3 or 4. It averages between 18% and 35% clay and more than 35% fine sand or coarser. It is neutral or mildly alkaline. The C horizon has hue of 2.5Y or 10YR. It is moderately or strongly alkaline.

Principal Associated Soils. These are the Olney soils. Olney soils lack bedrock above 40 inches.

Haverson Series

Typifying Pedon. Haverson sandy loam—rangeland. (Colors are for dry soil unless otherwise noted.)

A1 0-6"—Grayish brown (10YR 5/2) sandy loam, dark grayish brown (10YR 4/2) moderate fine crumb structure; soft, very friable, slightly sticky, slightly plastic; many very fine and fine roots; mildly alkaline (pH 7.6); abrupt smooth boundary; 3 to 6 inches thick.

C1 6-10"—Light brownish gray (10YR 6/2) clay loam, dark grayish brown (10YR 4/2) moist; weak medium and fine subangular blocky structure; slightly hard, friable, sticky, plastic; common fine and very fine roots; calcareous; moderately alkaline (pH 8.0); abrupt smooth boundary; 0 to 10 inches thick.

C2 10-60"—Grayish brown (10YR 5/2) loam, dark grayish brown (10YR 4/2) clay loam, and pale brown (10YR 6/3) sandy loam and sandy clay loam; massive; soft, very friable; few very fine and fine roots to 20 inches; common medium and fine pockets of organic stains throughout; calcareous; strongly alkaline (pH 8.5).

Type Location. Converse County, Wyoming; NW¼NW¼ of Section 31, T. 40 N., R. 68 W.

Range in Characteristics. The soils are usually calcareous throughout but some pedons are leached a few inches. The control section is stratified with strata ranging in texture from sandy loam to clay loam. Weighed average clay ranges from 18% to 35%. It has more than 15% but less than 35% fine or coarser sand. Coarse fragments range from 0% to 15%. The A horizon has hue of 2.5Y or 10YR, value of 5 or 6 dry and 3 through 5 moist, and chroma of 2 or 3. It is mildly or moderately alkaline. The C horizon has hue of 2.5Y through 7.5YR. Degree of stratification is variable. It is moderately or strongly alkaline.

Principal Associated Soils. These are the Glenberg and Lohmiller soils. Glenberg soils have less than 18% clay in the control section. Lohmiller soils have more than 35% clay in the control section.

Olney Series

Typifying Pedon. Olney sandy loam—rangeland. (Colors are for dry soil unless otherwise noted.)

A1 0-5"—Pale brown (10YR 6/3) sandy loam, brown (10YR 5/3) moist; moderate fine crumb structure; soft, very friable; common fine and very fine, few medium roots; neutral (pH 7.2); clear smooth boundary; 4 to 6 inches thick.

B1 5-10"—Pale brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) moist; weak medium prismatic that parts to moderate medium and fine subangular blocky structure; slightly hard, very friable, slightly sticky, slightly plastic; common very fine and fine, few medium roots; thin patchy glossy coatings on vertical faces of peds; neutral (pH 7.2); clear smooth boundary; 3 to 6 inches thick.

B2t 10-24"—Light yellowish brown (10YR 6/4) sandy clay loam, brown, (10YR 5/3) moist; moderate medium prismatic that parts to moderate medium and fine subangular blocky structure; hard, friable, sticky, plastic; few very fine and fine roots; thin nearly continuous glossy coatings; alkaline (pH 7.4); clear smooth boundary; 5 to 15 inches thick.

B3ca 24-30"—Light yellowish brown (10YR 6/4) sandy clay loam, brown (10YR 5/3) moist; weak medium and fine subangular blocky structure; few patchy glossy coatings on faces of peds; few soft rounded masses and seams of secondary calcium carbonate; moderately alkaline (pH 8.0); gradual wavy boundary.

Cca 30-60"—Very pale brown (10YR 7/4) sandy loam, light yellowish brown (10YR 6/4) moist; massive; slightly hard, very friable; moderately alkaline (pH 8.2).

Type Location. Converse County, Wyoming; SE¼ of NW¼ of Section 14, T. 36 N., R. 72 W.

Range in Characteristics. Depth to calcareous material ranges from 10 to 24 inches. Thickness of the solum ranges from 15 to 30 inches. Coarse fragments range from 0% to 15%. The A horizon has hue of 2.5Y or 10YR, value on 5 or 6 dry and 3 through 5 moist, and chroma of 2 or 3. It is neutral or mildly alkaline. The B2t horizon averages between 18% and 35% clay and more than 35% find sand or coarser. It is neutral or mildly alkaline. The C horizon has hue of 2.5Y or 10YR. It is moderately or strongly alkaline.

Principal Associated Soils. These are the Bowbac and Renohill soils. Bowbac soils have a paralithic contact at depths of 20 to 40 inches. Renohill soils have more than 35% clay in the B2t horizon.

Renohill Series

Typifying Pedon. Renohill clay loam—rangeland. (Colors are for dry soil unless otherwise noted.)

A1 0-5"—Light brownish gray (10YR 6/2) clay loam, grayish brown (10YR 5/2) moist; moderate fine and very fine subangular blocky structure; slightly hard, friable, sticky, plastic; common very fine and fine, few medium roots; moderately alkaline (pH 7.6); clear smooth boundary 3 to 6 inches thick.

B2t 5-16"—Light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) moist; weak coarse prismatic that parts to moderate coarse and medium angular blocky structure; hard, firm, sticky, plastic; few fine and very fine roots; moderately thick continuous glossy coatings on faces of peds; some pockets of olive brown (2.5Y 4/4) sandy material; mildly alkaline (pH 7.6); clear smooth boundary; 3 to 14 inches thick.

B3ca 16-25"—Light brownish gray (2.5Y 6/2) sandy clay loam, grayish brown (2.5Y 5/2) moist; weak medium and fine angular blocky structure; hard friable sticky, plastic; patches of thin glossy coatings on faces of peds; calcareous; few fine soft rounded masses of secondary calcium carbonate; mildly alkaline (pH 7.8); gradual smooth boundary.

Cr 25-30"—Calcareous sandy shale.

Type Location. Converse County, Wyoming; SW¼ of NE¼ of Section 14, T. 36 N., R. 73 W.

Range in Characteristics. Depth to calcareous material ranges from 6 to 20 inches. Thickness of the solum ranges from 15 to 30 inches. Depth to bedrock ranges from 20 to 40 inches. The A horizon has hue of 2.5Y or 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 2 or 3. It is neutral or mildly alkaline. The B2t horizon has hue of 2.5Y or 10YR, value of 5 or 6 dry and 4 or 5 moist, and chroma of 2 through 5. It has 35% to 50% clay and more than 15% fine or coarser sand. It is

neutral or mildly alkaline. The C horizon has hue of 2.5Y or 10YR. It is moderately or strongly alkaline.

Principal Associated Soils. These are the Briggsdale, Cushman, Olney, Shingle, and Ulm soils. Briggsdale soils have more than 15% (absolute) clay increase in the argillic. Cushman and Olney soils have 18% to 35% clay in the argillic. Olney soils also have bedrock above 40 inches. Shingle soils lack argillic horizons and have bedrock above 20 inches. Ulm soils lack bedrock above 40 inches.

Samsil Series

The samsil series is a clayey, montmorillonitic (calcareous), mesic, shallow Ustic Torriorthent. Typically, the Samsil soils have light brownish gray friable clay A horizons abovt 2 inches thick, light brownish gray friable clay AC horizons about 5 inches thick, and light brownish gray and light olive gray friable shaly C horizons underlain by light gray shale at a depth of about 17 inches.

Typifying Pedon. Samsil clay—on a convex, SSW facing slope of 15% under native grass. (Colors are for dry soil unless otherwise stated. When described, the soil was moist to 12 inches, dry from 12 to 21 inches, and moist below 21 inches.)

A1 0-2"—Light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; moderate fine granular structure; slightly hard, friable, sticky, plastic; common roots; few very fine fragments of shale; slight effervescence; mildly alkaline; clear wavy boundary; 2 to 4 inches thick.

AC 2-7"—Light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) moist; weak medium subangular blocky structure parting to weak medium granular structure; hard, friable, sticky, plastic; common roots; common fine fragments of shale; slight effervescence; mildly alkaline; clear wavy boundary; 0 to 6 inches thick.

C1 7-11"—Light brownish gray (2.5Y 6/2) shaly clay, dark grayish brown (2.5Y 4/2) crushing to grayish brown (2.5Y 5/2) moist; massive; hard, friable sticky, plastic; common roots; fine and medium fragments of shale make up about 30% by volume of mass; few fine faint stains of olive yellow (2.5Y 6/6); slight effervescence; mildly alkaline; gradual wavy boundary.

C2 11-17"—Light olive gray (5Y 6/2) shaly clay, olive gray (5Y 5/2) moist; massive; hard, friable, sticky, plastic; common roots; fine, medium, and coarse fragments of shale make up about 50% by volume of mass; common distinct stains of olive yellow (2.5Y 6/6) on faces of shale fragments; few fine and medium segregations of lime; slight effervescence; moderately alkaline; gradual wavy boundary. (Combined C1 and C2 horizons are 2 to 10 inches thick.)

C3 17-40"—Light gray (5Y 7.2) bedded shale; olive gray (5Y 5/2) moist; soft when moist but hard and brittle when dry; few roots; few iron and manganese stains in upper part.

Type Location. Pennington County, South Dakota; about 3 miles east of Wasta; 1,515 feet east and 1,120 feet south of the NW corner of Section 12, T. 1 N., R. 14 E.; 24 feet south of C & GS BM J381 (1962) on west side of Jensen Road.

Range in Characteristics. Depth to bedded shale ranges from 4 to 20 inches. Horizon above the shale ranges from loose to hard when dry, friable or firm when most, and slightly sticky or sticky and plastic or slightly plastic when wet. These horizons contain free lime; effervescence ranges from slight to strong and from mildly alkaline through strongly alkaline. The C1 and C2 horizons and upper part of the C3 horizon commonly have segregations of lime, gypsum, and other salts. The horizons above the shale average between 45% and 65% clay. Colors throughout, including mottles and stains, are inherited from the shale. The A1 horizon has hue of 5Y, 2.5Y, or 10YR, value of 5 through 7 dry and 3 through 5 moist, and chroma of 2 through 4. It is clay or silty clay and commonly contains few or common fragments of shale ranging from 2 to 25 millimeters in diameter. It has fine or medium subangular blocky or fine or very fine granular structure. The upper ¼ to ½ inches commonly is a fragile crust or mulch of very fine granules when dry. The AC and C horizons have hue of 5Y, 2.5Y, or 10YR, value of 5 through 7 dry and 3 through 5 moist, and chroma of 1 through 4. The C1 and C2 horizons contain from 5% to more than 50% fragments of shale that range from less than 2 to 35 millimeters in diameter. The C3 horizon or bedded shale has the same range in color as the overlying C horizons. It ranges from medium acid to moderately alkaline. The upper part or weathered zone is platy and contains free carbonates. The lower part separates to angular blocks and commonly lacks free carbonates except from segregations of lime as coatings or masses between fracture faces.

Competing Series and Their Differentiae. These are Chantier, Danko, Epsie, Lismas, and Midway soils in the family, and Conata, Grummit, Lisam, Louviers, Orella, Sansarc, and Yawdim soils. Chantier soils have B horizons. Lismas soils have harder consistence throughout. Midway soils contain less than 45% clay. Grummit soils are acid. Lisam and Yawdim soils are frigid. Louviers soils are nonacid. Orella soils are strongly or very strongly alkaline and contain from 8% to 30% exchangeable sodium. Sansarc soils are dry for a shorter period.

Setting. Samsil soils are on slope breaks of dissected shale plains. Surfaces mainly are convex, and slope gradients range from 2% to 45% or more. The soil formed in residuum weathered from shale. Mean annual temperature ranges from about 45 to 54°F; mean annual precipitation ranges from 12 to 17 inches, most of which falls in the spring and summer.

Principal Associated Soils. These are the Kyle, Pierre, and Swanboy soils, which are greater than 20 inches to shale. They are on the smoother parts of nearby landscapes.

Drainage and Permeability. Well-drained, somewhat excessively drained, and excessively drained. Surface runoff is slow on gently sloping areas and very rapid on steep areas. Permeability is slow.

Use and Vegetation. Rangeland. Native vegetation is little bluestem neddle-and-thread, sideoats grama, blue grama, green needlegrass, sedges, and forbs.

Distribution and Extent. Southwestern South Dakota and parts of Nebraska, Wyoming, and Colorado. The soil is extensive.

Series Established. Stanley County, South Dakota, 1967.

Remarks. Samsil soils were classified as Lithosols in the modified 1938 yearbook classification system.

Shingle Series

Typifying Pedon. Shingle sandy clay loam—rangeland. (Colors are for dry soil unless otherwise noted.)

A1 0-4"—Pale brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) moist; weak medium and fine crumb structure; soft, very friable, slightly sticky, slightly plastic; common medium fine roots; moderately alkaline (pH 7.9); clear smooth boundary; 3 to 6 inches thick.

C1 4-19"—Pale brown (10YR 6/3) sandy clay loam, brown (10YR 5/3) moist; massive; slightly hard, friable, slightly plastic; few fine roots; 15% fine shale and sandstone fragments easily crushed; calcareous; moderately alkaline (pH 7.9); clear smooth boundary; 6 to 15 inches thick.

Type Location. Converse County, Wyoming NW¼ of Section 15, T. 40 N., R. 70 W.

Range in Characteristics. Depth to soft bedrock is 10 to 20 inches. Depth to calcareous materials is 0 to 10 inches. The control section averages between 18% and 35% clay and has more than 15% but less than 35% fine or coarser sand. It has 0% to 15% fine shale or sandstone fragments.. The A horizon has hue of 5Y through 7.5YR, value of 5 through 7 and 3 through 6 moist, and chroma of 1 through 4. It is mildly through stongly alkaline. The C horizon has hue of 5Y through 7.5YR. It is moderately or strongly alkaline.

Principal Associated Soils. These are the Renohill, Samsil, and Tassel soils. Renohill soils have an argillic horizon. Samsil soils have more than 35% clay in the control section. Tassell soils have less than 18% clay in the control section.

Rough Broken Land/Rock Outcrop

The rock outcrop consists of multicolored, calcareous to noncalcareous, coarse to fine-textured, soft to hard sandstone, shales, and siltstone.

TABLE BUA-1

GENERAL WATER ANALYSES FROM WELL SAMPLES COLLECTED ON NOVEMBER 25, 1975
(Values in mg/l except as indicated.)

	P-2 Overburden		P-4 Overburden		P-4 (Duplicate) Overburden		P-6 Overburden		P-7 Overburden		P-10 Overburden	
ION	Diss.	Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.	Total
Calcium	88	101	76	87	64	82	71	86	58	510	300	540
Magnesium	20	30	29	20	30	28	27	27	59	270	80	205
Sodium	8	10	150	165	155	145	355	310	365	370	34	87
Potassium	1.8	2.3	9.3	9.0	9.3	8.8	11	12	12	445	4.5	205
Bicarbonate	165	-	425	-	425	-	530	-	1,075	-	340	-
Carbonate	0	-	0	-	0	-	0	-	0	-	0	-
Hydroxyl	0	-	0	-	0	-	0	-	0	-	0	-
Sulfate	264	303	213	189	216	198	483	447	138	132	600	567
Chloride	5	-	7	-	5	-	17	-	8	-	5	-
Total Phosphorus	0.18	0.25	0.034	0.071	0.067	0.33	0.054	0.26	0.12	23	0.21	18
Nitrate as Nitrogen	1.8	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-	<0.1	-
Temperature at Collection (^{o}C)	8.5	-	8.0	-	8.0	-	11.5	-	6.0	-	7.5	-
pH	6.20	-	7.60	-	7.60	-	7.85	-	7.85	-	7.30	-

TABLE BUA-1
(cont'd)

GENERAL WATER ANALYSES FROM WELL SAMPLES COLLECTED ON NOVEMBER 25, 1975
(Values in mg/l except as indicated.)

	P-2 Overburden		P-4 Overburden		P-4 (Duplicate) Overburden		P-6 Overburden		P-7 Overburden		P-10 Overburden	
ION	Diss.	Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.	Total	Diss.	Total
Total Dissolved Solids	374	-	704	-	684	-	1,120	-	1,260	-	944	-
Total Suspended Solids	-	22	-	34	-	16	-	130	-	20,600	-	10,520
Total Solids	-	396	-	738	-	700	-	1,250	-	21,900	-	11,400

Source: Shell Oil Company 1977.

TABLE BUA-2

TRACE ELEMENT CONCENTRATIONS IN WELL WATER SAMPLES COLLECTED ON THE BUCKSKIN MINE SITE, NOVEMBER 25, 1976
(All values are in mg/l.)

ELEMENT	WELL DESIGNATIONS											
	P-2 Overburden		P-4 Overburden		P-4 (Duplicate) Overburden		P-6 Overburden		P-7 Overburden		P-10 Overburden	
	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**
Aluminum	0.22	0.78	0.89	7.7	4.1	4.1	0.66	7.4	1.6	≈3,000	1.0	510
Antimony	–	–	–	–	–	0.001	–	–	–	0.012	–	0.005
Arsenic	–	–	–	–	–	–	0.001	0.037	0.001	0.037	0.005	0.016
Barium	0.067	0.024	0.22	0.23	0.062	0.063	0.020	0.048	0.023	12.0	0.42	1.9
Beryllium	–	–	–	–	–	–	–	–	–	0.14	–	–
Bismuth	–	–	–	–	–	–	–	–	–	0.017	–	0.003
Boron	<0.1	***	<0.10	***	<0.10	***	<0.17	***	<0.14	***	<0.1	***
Bromine	0.002	0.032	0.004	0.044	0.002	0.032	0.029	0.075	0.008	0.062	0.28	0.027
Cadmium	–	–	–	–	–	–	–	–	–	0.026	0.002	0.011
Cerium	–	–	–	0.003	0.001	0.003	–	0.002	–	2.0	–	0.86
Cesium	–	–	–	–	–	–	–	–	–	0.10	–	0.019
Chromium	–	–	–	0.005	0.001	0.001	–	0.004	–	1.7	–	0.68
Cobalt	–	0.002	–	–	0.001	–	–	–	–	0.36	0.001	0.079
Copper	0.004	0.006	0.015	0.003	0.002	0.003	0.011	0.012	0.002	0.53	0.001	0.23

TABLE BUA-2
(cont'd)

TRACE ELEMENT CONCENTRATIONS IN WELL SAMPLES COLLECTED IN THE BUCKSKIN MINE SITE, NOVEMBER 25, 1976
(All values are in mg/l.)

	WELL DESIGNATIONS											
	P-2 Overburden		P-4 Overburden		P-4 (Duplicate) Overburden		P-6 Overburden		P-7 Overburden		P-10 Overburden	
ELEMENT	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**
Dysprosium	-	-	-	-	-	-	-	-	-	0.092	-	0.040
Erbium	-	-	-	-	-	-	-	-	-	0.010	-	0.004
Europium	-	-	-	-	-	-	-	-	-	0.009	-	0.005
Gadolinium	-	-	-	-	-	-	-	-	-	0.014	-	0.007
Gallium	-	-	-	0.001	-	-	-	0.001	-	0.16	0.002	0.14
Germanium	-	0.002	-	-	-	-	-	-	-	0.034	-	0.014
Gold	-	-	-	-	-	-	-	-	-	-	-	-
Hafnium	-	-	-	-	-	-	-	-	-	0.066	-	0.029
Holmium	-	-	-	-	-	-	-	-	-	0.006	-	0.003
Indium	****	****	****	****	****	****	****	****	****	****	****	****
Iodine	-	-	0.005	0.01	0.001	0.009	0.003	0.017	-	0.024	0.004	0.030
Iridium	-	-	-	-	-	-	-	-	-	-	-	-
Iron	0.046	0.33	0.035	0.46	0.18	0.19	0.019	0.78	0.33	800	0.96	640
Lanthanum	-	-	-	0.003	-	0.001	-	0.001	-	0.98	-	0.42
Lead	0.026	0.002	0.001	0.005	0.005	0.002	-	0.009	-	0.34	0.001	0.14

TABLE BUA-2
(cont'd)

TRACE ELEMENT CONCENTRATIONS IN WELL SAMPLES COLLECTED IN THE BUCKSKIN MINE SITE, NOVEMBER 25, 1976
(All values are in mg/l.)

	WELL DESIGNATIONS											
	P-2 Overburden		P-4 Overburden		P-4 (Duplicate) Overburden		P-6 Overburden		P-7 Overburden		P-10 Overburden	
ELEMENT	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**
Lithium	0.016	0.02	0.006	0.007	0.080	0.053	–	0.054	0.15	5.2	0.18	0.45
Lutetium	–	–	–	–	–	–	–	–	–	0.014	–	0.006
Manganese	0.037	0.026	0.008	0.007	0.007	0.003	0.007	0.012	0.33	4.2	1.0	2.8
Mercury	.0003	.0003	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Molybdenum	0.004	0.003	0.009	0.019	0.008	0.018	0.003	0.003	0.015	0.062	0.004	0.009
Neodymium	–	–	–	–	–	–	–	–	–	0.24	–	0.11
Nickel	–	–	–	0.002	–	0.002	–	–	–	0.67	0.002	0.057
Niobium	–	–	–	–	–	–	–	0.001	–	0.33	–	0.14
Osmium	–	–	–	–	–	–	–	–	–	–	–	–
Palladium	–	–	–	–	–	–	–	–	–	–	–	–
Platinum	–	–	–	–	–	–	–	–	–	–	–	–
Praseodymium	–	–	–	–	–	–	–	–	–	0.096	–	0.089
Rhenium	****	****	****	****	****	****	****	****	****	****	****	****
Rhodium	–	–	–	–	–	–	–	–	–	–	–	–

TABLE BUA-2
(cont'd)

TRACE ELEMENT CONCENTRATIONS IN WELL WATER SAMPLES COLLECTED ON THE BUCKSKIN MINE SITE, NOVEMBER 25, 1976
(All values are in mg/l.)

	WELL DESIGNATIONS											
	P-2 Overburden		P-4 Overburden		P-4 (Duplicate) Overburden		P-6 Overburden		P-7 Overburden		P-10 Overburden	
ELEMENT	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**
Rubidium	-	0.003	0.004	0.023	0.004	0.014	0.013	0.014	0.007	2.7	0.002	0.58
Ruthenium	-	-	-	-	-	-	-	-	-	-	-	-
Samarium	-	-	-	-	-	-	-	-	-	0.045	-	0.005
Scandium	-	-	-	-	-	-	-	-	-	0.013	-	0.056
Selenium	-	-	-	-	-	-	0.005	-	-	0.034	-	0.021
Silicon	18.0	26.0	6.9	13.0	18	12	2.4	2.6	2.6	≈5,000	15.0	≈2,200
Silver	0.002	-	-	-	-	-	-	-	-	0.004	-	0.005
Strontium	0.13	0.006	0.65	0.68	0.31	0.18	0.10	1.2	0.025	2.2	0.95	3.6
Tantalum	-	-	-	-	-	0.001	-	-	0.001	0.032	0.002	0.014
Tellurium	-	-	-	-	-	-	-	-	-	0.002	-	<0.001
Terbium	-	-	-	-	-	-	-	-	-	0.007	-	0.003
Thallium	-	-	-	-	-	-	-	-	-	0.027	-	0.004
Thorium	-	-	-	-	-	-	-	-	-	0.13	-	0.058
Thulium	-	-	-	-	-	-	-	-	-	0.002	-	0.001

TABLE BUA-2
(cont'd)

TRACE ELEMENT CONCENTRATIONS IN WELL WATER SAMPLES COLLECTED ON THE BUCKSKIN MINE SITE, NOVEMBER 25, 1976
(All values are in mg/1.)

	WELL DESIGNATIONS											
	P-2 Overburden		P-4 Overburden		P-4 (Duplicate) Overburden		P-6 Overburden		P-7 Overburden		P-10 Overburden	
ELEMENT	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**	Diss.*	Total**
Tin	0.001	-	-	0.002	-	0.001	-	0.001	-	0.028	-	0.029
Titanium	-	0.02	<0.002	0.13	0.024	0.12	0.002	0.022	0.093	83.0	0.003	36.0
Tungsten	-	-	-	-	-	-	-	-	-	0.083	-	0.014
Uranium	0.001	0.002	-	-	0.002	0.002	-	-	0.001	0.060	0.004	0.026
Vanadium	-	0.001	0.002	0.004	0.001	0.001	-	0.006	0.003	2.4	-	1.0
Ytterbium	-	-	-	-	-	-	-	-	-	0.024	-	0.025
Yttrium	-	-	-	-	-	-	-	-	-	0.27	-	0.012
Zinc	0.045	0.086	0.002	0.019	0.041	0.018	0.007	0.074	0.007	1.4	0.040	1.2
Zirconium	-	0.001	-	0.004	-	0.004	-	0.003	-	4.7	0.001	5.7

Source: Shell Oil Company 1977.

* Dissolved. Analyses performed on sample of unfiltered, unpreserved water.
** Analyses performed on sample that was filtered then preserved with nitric acid.
*** Colorimetric method used for boron analysis.
**** Internal standard.

TABLE BUA-3

WATER ANALYSES FOR MAJOR DISSOLVED CONSTITUENTS AND PHYSICAL PARAMETERS FROM COAL
DECEMBER 2, 1976
(All values in mg/l except as noted.)
Data furnished by the applicant.

Parameter	Well P-4
Calcium	45.2
Magnesium	21.5
Potassium	11.2
Sodium	266
Bicarbonate	845
Chloride	14
Sulfate	5.3
Nitrate (as N)	0.27
Fluoride	7.4
Silica (as SiO_2)	4.5
Total Phosphorous (as P)	0.05
Total Dissolved Solids	843
Total Suspended Solids	39
Total Solids	882
Temperature (field) (^{o}C)	10.0
pH (units)	7.30
Chromium	<0.03
Iron (dissolved)	0.2
Manganese	0.3
Mercury (µg/l)	0.2
Selenium (µg/l)	<2.5
Zinc	0.05

TABLE BUA-4

WATER ANALYSIS FOR TOTAL CONCENTRATIONS OF SELECTED ELEMENTS FROM COAL
DECEMBER 2, 1976
(All values in mg/l except as noted.)
Data furnished by the applicant.

Parameter	Well P-4
Aluminum	0.5
Arsenic (μg/l)	<1
Boron	<0.04
Calcium	50.5
Chromium	0.7
Copper	0.6
Iron	1.6
Lead	0.05
Magnesium	23.4
Manganese	0.3
Mercury (μg/l)	<0.5
Nickel	0.02
Potassium	12
Selenium (μg/l)	<2.5
Silica	4.7
Sodium	275
Zinc	0.15

TABLE BUA-5

RESULTS OF ANALYSES FOR MAJOR DISSOLVED CONSTITUENTS FROM ALLUVIUM
AUGUST 13, 1976
(All values in mg/l.)
Data furnished by the applicant.

Parameters	OT-2B
Calcium	310
Magnesium	48.5
Potassium	38.5
Sodium	1,128
Chloride	18.5
Sulfate	4,043
Bicarbonate (as $CaCO_3$)	724
Silica	8.3

TABLE BUA-6

COMPARISON OF WATER QUALITY IN RAWHIDE CREEK WITH APPLICABLE STANDARDS

	Maximum (mg/l)*	Discharge (cfs)**	Minimum (mg/l)*	Discharge (cfs)**	Suggested Limits for Drinking Water (mg/l)*	Suggested Biological Limits (mg/l)*
Dissolved calcium (Ca)	400	NA	390	0.18	less than 75	± 25 (for crustaceans) needed
Dissolved magnesium (Mg)	490	NA	470	0.18	less than 30	less than 14
Dissolved sodium (Na)	685	NA	650	NA	less than 270	85 needed, 500 is toxic
Dissolved bicarbonate (HCO_3)	638	NA	334	6.7	less than 150	more than 100 needed
Dissolved sulfate (SO_4)	4,000	9.6	780	1.0	less than 250	less than 90
Dissolved solids	5,890	.18	1,410	6.7	less than 500	more than 400 needed

Sources: McKee and Wolf 1963, National Academy of Sciences 1972, U.S. Environmental Protection Agency 1976a.

Note: Three water samples were taken from Rawhide Creek at U.S. Highway 14/16 between March 1975 and August 1976 to obtain the figures above.

NA = Not available.

* miligrams per liter
** cubic feet per second

FISH AND WILDLIFE

BIRDS AND MAMMALS OBSERVED ON THE BUCKSKIN SITE
(Wyoming Game and Fish Department 1978)

BIRDS

Brewer's sparrow
Vesper sparrow
Lark bunting
Horned lark
Western meadowlark
Mourning dove
Sage grouse
Killdeer
Sage sparrow
Pintail
Shoveler
Blue-winged teal
American widgeon
Loggerhead shrike
Red-winged blackbird
Mallard
Upland plover
Marsh hawk
Ferruginous hawk
Swainson's hawk
Golden eagle
Prairie falcon
Burrowing owl
American kestrel
Red-tailed hawk
Lesser scaup
Horned grebe
Pied-billed grebe
American coot
Sharp-tailed grouse
Great horned owl
Eastern kingbird
Say's phoebe
Rock wren
Common grackle
Brewer's blackbird
Song sparrow
Barn swallow
Cliff swallow
Black-billed magpie

MAMMALS

Pronghorn
Mule deer
Black-tail prairie dog
White-tail jackrabbit
Desert cottontail
Mountain cottontail
Least chipmunk
Thirteen-lined ground squirrel
Deer mouse
Northern grasshopper mouse
Prairie vole
Meadow vole
Plains pocket gopher
Muskrat
Porcupine
Badger
Coyote

TABLE BUA-7

CONTRAST RATING FOR BUCKSKIN MINE AS SEEN FROM U.S. HIGHWAY 14/16

Short Term
(Life of the Mine)

Feature	Element*		Contrast**		Score	Maximum Possible Score
	Form (4)	x	Moderate (2)	=	8	
	Line (3)	x	Strong (3)	=	9	
Land Surface	Color (2)	x	Strong (3)	=	6	
	Texture (1)	x	Moderate (2)	=	2	
	Feature Contrast Score			=	25 (unacceptable)	30
	Form (4)	x	Weak (1)	=	4	
	Line (3)	x	Moderate (2)	=	6	
Vegetation	Color (2)	x	Moderate (2)	=	4	
	Texture (1)	x	Weak (1)	=	1	
	Feature Contrast Score			=	15 (medium)	30
	Form (4)	x	Weak (1)	=	4	
	Line (3)	x	Weak (1)	=	3	
Structures	Color (2)	x	Weak (1)	=	2	
	Texture (1)	x	Weak (1)	=	1	
	Feature Contrast Score			=	10 (low)	30
	Grand Total				50 (medium)	90

TABLE BUA-7
(cont'd)

CONTRAST RATINC FOR BUCKSKIN MINE AS SEEN FROM U.S. HIGHWAY 14/16

Long Term
(After Completion of Reclamation)

Feature	Element*		Contrast**		Score	Maximum Possible Score
	Form (4)	x	Weak (1)	=	4	
	Line (3)	x	Weak (1)	=	3	
Land Surface	Color (2)	x	Moderate (2)	=	4	
	Texture (1)	x	Weak (1)	=	1	
	Feature Contrast Score			=	12 (medium)	30
	Form (4)	x	Weak (1)	=	4	
	Line (3)	x	Moderate (2)	=	6	
Vegetation	Color (2)	x	Moderate (2)	=	4	
	Texture (1)	x	Weak (1)	=	1	
	Feature Contrast Score			=	15 (medium)	30
	Form (4)	x	None (0)	=	0	
	Line (3)	x	None (0)	=	0	
Structures	Color (2)	x	None (0)	=	0	
	Texture (1)	x	None (0)	=	0	
	Feature Contrast Score			=	0 (none)	90
	Grand Total				27 (low)	90

Note: The maximum allowable feature contrast score for the Buckskin site is 20 (Class IV designation). The mine would generate a short-term feature contrast score of 25 for land surface, 5 points more than an acceptable level. Bureau of Land Management Manual 632 contains a detailed description of the contrast rating procedure.

* Rated on a scale of 1 to 4 depending on how easily contrast can be detected.

** Rated on a scale of 1 to 3.

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